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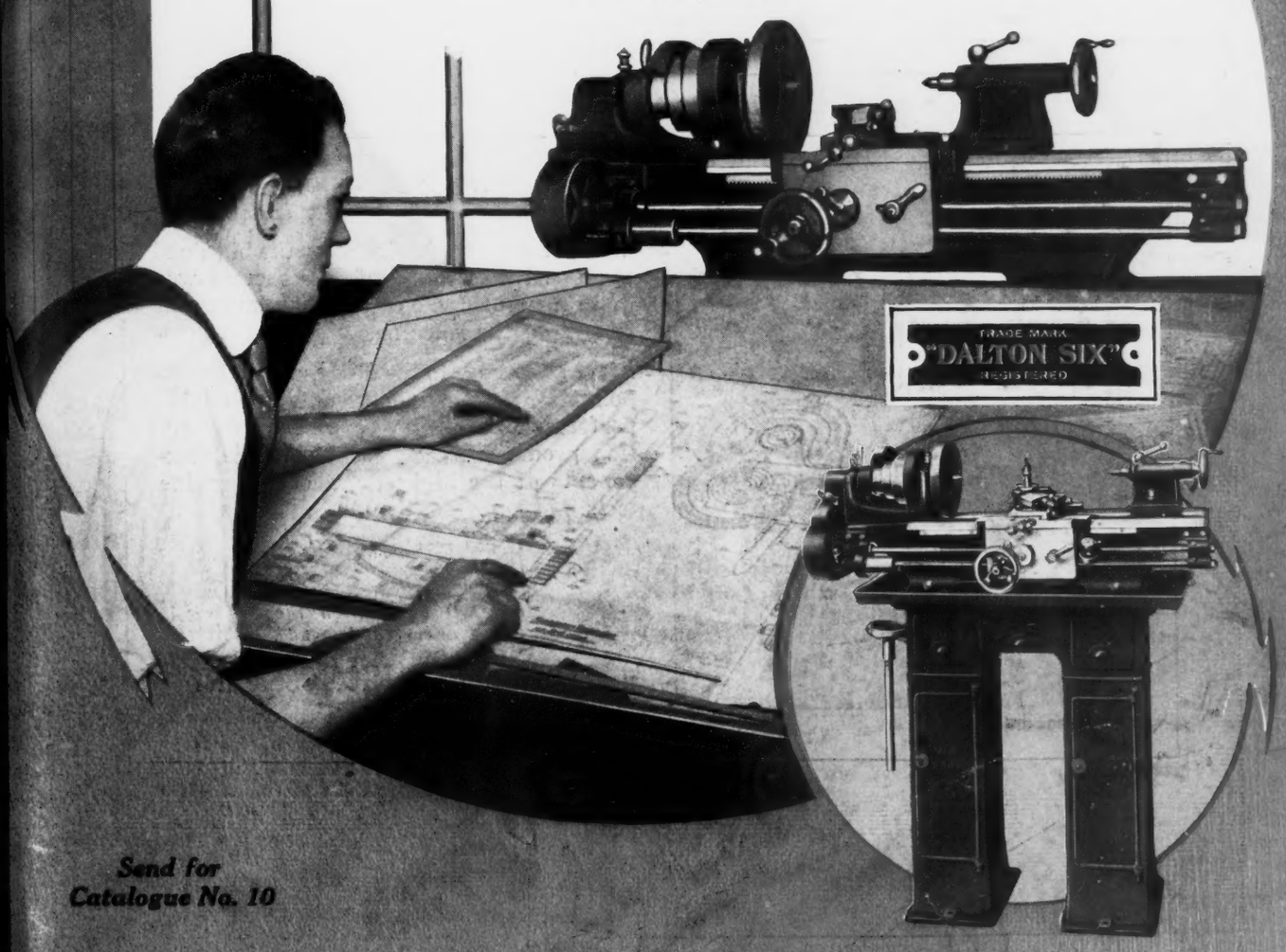

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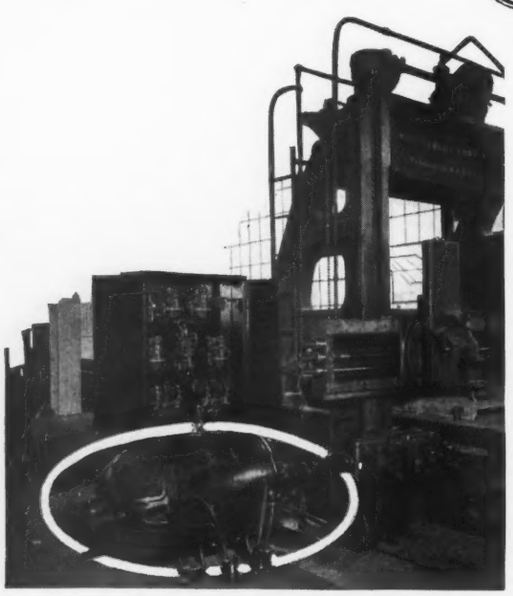

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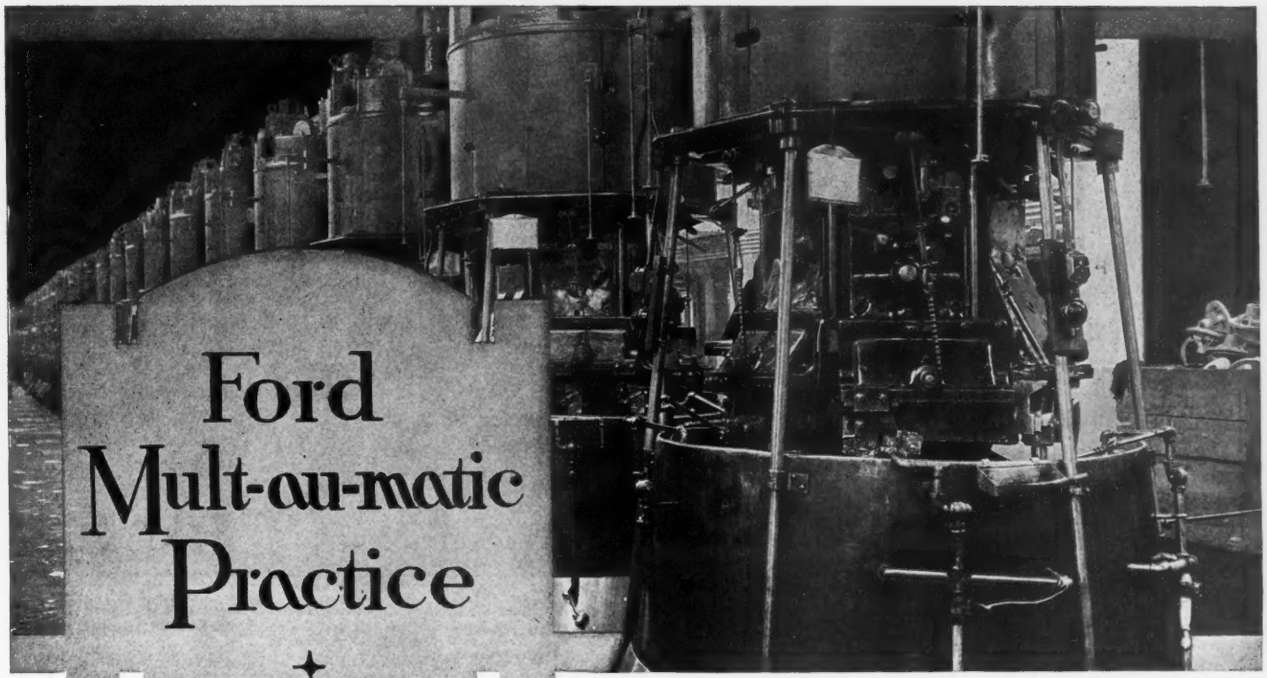


Ford Mult-au-matic Practice

Practice of the Ford Motor Co. in Machining Automobile Parts on Bullard Mult-au-matics

By EDWARD K. HAMMOND

SINCE the introduction of mult-au-matic vertical lathes by the Bullard Machine Tool Co., of Bridgeport, Conn., these machines have found successful application in the Ford Motor Co.'s plant, where there are enormous quantities of duplicate parts on which turning, boring, drilling, reaming, facing, or threading operations must be performed. Machines of this type were introduced to the trade nearly six years ago, but as their application is most successful in those plants which have large quantities of repetition work, it may be that some readers of MACHINERY have not had an opportunity to become familiar with the characteristics of this type of machine tool; and as a clear understanding of the following article is dependent upon a general knowledge of the principles of operation, a brief description of their design will be given before entering into a discussion of their use for specific machining operations.

At the time of their introduction, the design of the Bullard mult-au-matics represented a marked departure from established practice in machine tool design. These machines are essentially multiple-spindle vertical lathes which are semi-automatic in operation; hence the name "mult-au-matic," which signifies a multiplicity of spindles and an automatic functioning of the mechanism. Machines of this type are built in six-spindle and twelve-spindle styles, according to the requirements of the work which is to be done on them, but the general method of operating both styles of machines is the same. They consist of a frame or turret in which are mounted, in equal spacing and at the same radial distance, the rotating work-holding tables and spindles—provision being made for indexing the turret or carrier with its contained spindles from station to station, so that the work may be located beneath the tools carried by successive vertical tool-slides, which are mounted on the faces of a hexagonal shaped column. Wide ranges in the speed of rotation of work are obtainable at each station, and each tool-head is, in addition, equipped with an independent feed movement. In this way, it is possible to have the desired combination of speed and feed for each table, according to the requirements of the machining operation which is to be performed on the work while located at a given station on the machine.

Factors which Improve Rates of Production

The saving of time in machining operations and the rates of production which are attained on the mult-au-matics are due to the fact that there is practically no idle time for either the machine or its operator. There is one station, known as a loading station, and five stations over which tool-carrying heads are mounted. While the operator is setting up a piece of work or removing a completed piece at the operating station, all of the successive operations which are required on the work are being simultaneously performed at the other five stations of the machine. Consequently, the total machining time is cut down to the period required to complete the longest machining operation, plus the indexing time. As the operations performed at each station are completed, the tools are automatically withdrawn from the work, and upon completion of the longest operation the work-tables are automatically indexed to bring each of the pieces into position for performing the next machining operation of the sequence. Attention has been called to the fact that turning, boring, drilling, reaming, facing, and threading operations can be performed on these machines, and none but simple tools, such as twist drills, reamers, and single-point turning and boring tools, are employed. Consequently, the expense of tooling is not an important factor. The machines are especially equipped for the specific machining operations on which they are to be employed, and in this connection, attention may be called to the fact that the tool-carrying slides over each station of

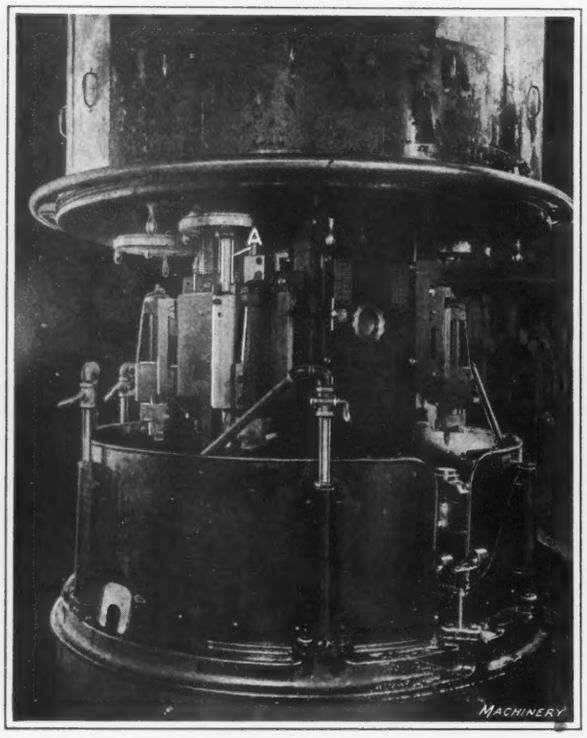


Fig. 1. Mult-au-matic equipped for machining Ford Triple Transmission Gear Blanks. Attention is called to the Drilling Spindle A provided on this Machine

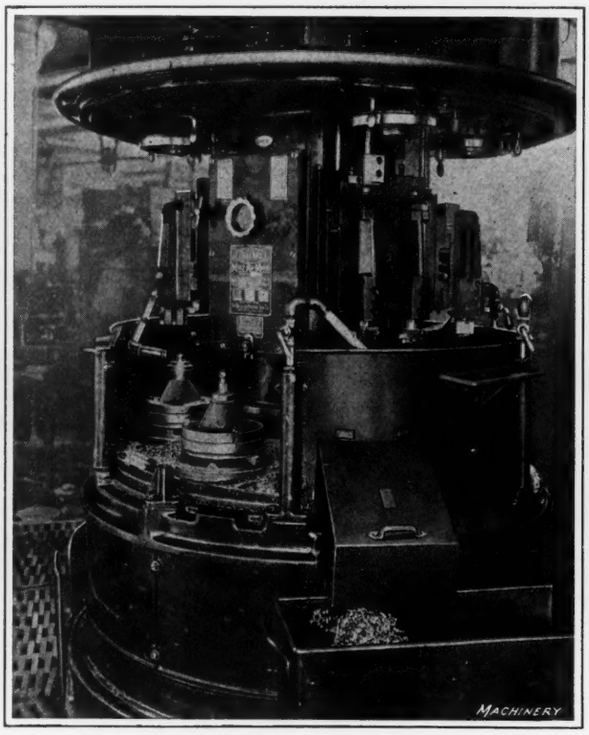


Fig. 2. Mult-au-matic on which Second Sequence of Operations is performed on Ford Triple Transmission Gear Blanks started on the Machine shown in Fig. 1

the machine are often especially designed, with the right rate of feed, etc., to meet the requirements of the work.

Variety of Work that is Handled

Reference has been made to the general classes of machining operations which are performed on these machines, and a brief consideration will make it apparent that the range of work which could be handled would be seriously restricted if some provision were not made for machining the great variety of pieces where it is necessary to either turn or bore tapered surfaces. To adapt the machines for work of this nature, the standard tool-carrying slides include a swivel base and a secondary slide which provides means for adjustment of the tool travel in either direction and at any angle within the circle. Tapered or conical surfaces, either convex or concave, may thus be readily machined.

Provision for Machining Irregular Shaped Work

By designing special tool-heads for installation at various stations on the machines, provision has been made for adapting mult-au-matics for economically producing many classes of irregular shaped work, which would otherwise be difficult to handle on a production basis. As a typical example of such specially designed tool-heads, attention is directed to the piece of work illustrated in Fig. 13, on which it is required to turn a spherical seat. It will be evident to any experienced mechanic that an attempt to use a standard machine tool for the quantity production of pieces of this form would entail a heavy manufacturing cost; but with a specially equipped mult-au-matic, the operations required on the spherical surface of this piece may be handled with little more trouble than straight cylindrical turning or boring. Similar provision can be made for machining other irregular shaped work of the same general character.

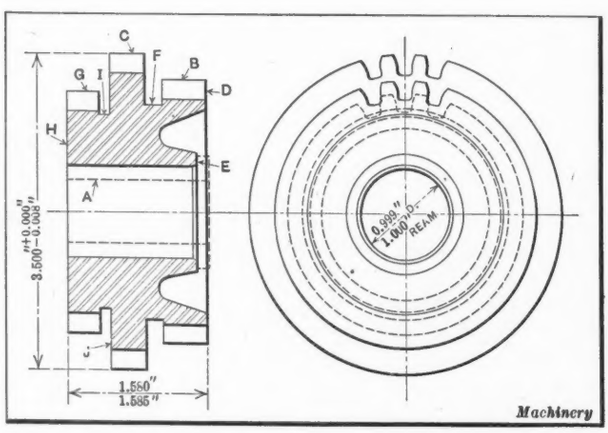


Fig. 3. Ford Triple Gear, the Blank for which was machined on Mult-au-matic shown in Figs. 1 and 2

Rotating Spindles for Drill Heads

Another important feature of the tooling of these machines is the provision of so-called drill heads, which are used in cases where it is desired to simultaneously drill a small hole at the center of a piece of work and turn a surface of considerably larger diameter on the same piece. It will be evident that if an attempt were made to rotate the work at a sufficiently high rate to afford an efficient cutting speed for the drill, the turning tool would be required to operate under such severe conditions that it would soon be destroyed; and on the other hand, reducing the speed of rotation of the work to a point where the correct cutting speed would be obtained for the turning tool, would mean that the cutting speed of the drill would be far too slow for efficient operation. Provision has been made for satisfactorily handling operations of this general character by having the turning tool mounted on the head in the usual way, while the drill is carried by a spindle supported by bearings in the head (secured to the tool-slide), with a driving shaft extending from the rear end of the spindle up to the feed works at the top of the machine. In this way, suitable gears may be employed to take power from the main drive and drive the drill spindle at the proper number of revolutions per minute for the size of hole to be drilled.

Classes of Work Done on Mult-au-matics

With a machine which has as wide a range of adaptability as the mult-au-

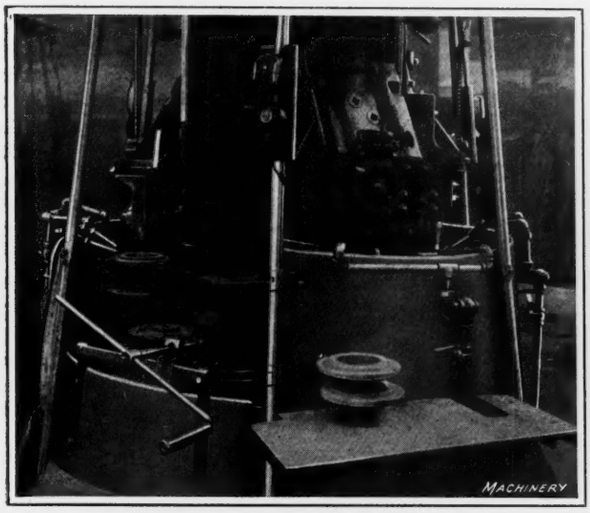


Fig. 4. Mult-au-matic equipped for performing First Sequence of Machining Operations on Ford Differential Gear-cases. Three-jaw Chucks hold the Work

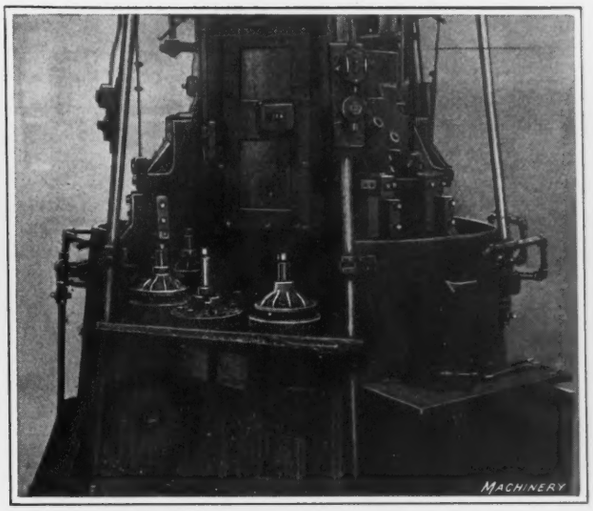


Fig. 5. Mult-au-matic equipped for performing Second Sequence of Operations on Ford Differential Gear-cases. Piloted Fixtures locate the Work from its Finished Bore

matic, it is difficult to make any general statement as to what constitutes the general classes of machining operations for the performance of which it is well suited. However a general statement may be made that the machine is adapted for handling any class of work which may be held by chuck jaws, or some other suitable means to support the piece in such a manner that it is possible to reach all surfaces on which turning, boring, facing, drilling, tapping, or threading operations have to be performed, without requiring the work to be reset. It must be borne in mind that this is a production machine, intended for use in the manufacture of duplicate parts. It is not true, however, that machines of this type can only be successfully employed in cases where there are sufficiently large quantities of the same piece to be handled to allow a machine to be kept running continuously on a single job, although such work enables the mult-au-matic to show its productive possibilities in the most favorable light, because no time is lost in changing the machine over from one job to another.

At the Ford Motor Co.'s plant, there are over 125 of these machines in operation, and when all of the machines have been delivered which are now on order, there will be a complete installation of 180 machines. Owing to the vast number and variety of pieces that are required for this firm's daily output of over 3,000 cars, it will be evident that each of the mult-au-matics can be kept constantly working on a single job, and in this way the ideal conditions of operation are attained. On the other hand, some jobbing shops which take contracts for the manufacture of moderate numbers of duplicate parts, have installed machines of this type for handling the work, and they are said to be successfully used for executing the various orders on which they are employed. Such a practice is not to be recommended, however, unless the quantity of parts on order is very large, or unless there is assurance that repeated orders will be received at regular intervals for the manufacture of a moderate quantity of work. This becomes self-evident when it is remembered that the time required for tooling-up a machine for handling a given job, if frequently taken from productive time, together with the cost of a wide variety of spe-

TABLE 1. SEQUENCE OF MACHINING OPERATIONS ON TRIPLE TRANSMISSION GEARS

Operation Number	Operation	Types of Cutting Tools Used
1	Load	
2	Drill half way through hole *A*, Fig. 3; turn outside of gears *B* and *C*	Twist drill and turning tools
3	Face surfaces *D* and *E*; cut clearance *F*	Combination facing and parting tool with cross-feed
4	Finish drilling hole *A*; finish-turn gears *B* and *C*	Twist drill and combination turning tools
5	Finish-face surfaces *D* and *E*; chamfer edges of top gears	Combination facing and chamfering tool with cross feed
6	Finish-turn outside diameters of gears *B* and *C*; bore hole *A*	Combination single-point turning and boring tools
	SEQUENCE OF OPERATIONS FOR SECOND SETTING OF WORK	
1	Load	
2	Rough-turn outside diameter of gear *G*	Single turning tool
3	Rough-face surface *H*; cut clearance *I*; face surface *J*	Combination facing and parting tool with cross-feed
4	Finish clearance *I*	Parting tool with cross-feed
5	Finish-face surfaces *H* and *J*	Simple facing tool with cross-feed
6	Finish-turn outside diameters of gears *C* and *G*; chamfer edges of gears	Combination turning and chamfering tool

Note: For the first operation, the work is held by three-jaw universal chucks which grip the outside diameter of gear G. For the second operation, a pilot enters hole A, and face E drops on a serrated plate at the bottom of the pilot, against which the work is clamped. Coolant is delivered to cutting tools at each station of the machines working on these forgings. Rate of production for first setting, 50 per hour; rate of production for second setting, 48 per hour.

TABLE 2. SEQUENCE OF MACHINING OPERATIONS ON DIFFERENTIAL GEAR-CASES

Operation Number	Operation	Types of Cutting Tools Used
1	Load	
2	Rough-bore holes *A* and *B*, Fig. 6; rough-turn face *C*; form radius in hole *D*	Combination boring, turning, and radius-forming tool
3	Rough-turn faces *E*, *F*, and *G*; chamfer corner *H*	Combination facing and chamfering tool with cross-feed from head
4	Finish surfaces rough-turned by Operation 3	Combination facing and chamfering tool with cross-feed from head
5	Ream hole *A* and finish-turn face *C*	Combination turning tool and reamer
6	Finish-bore hole *B*; finish-turn radius *D*; chamfer edges of rim *G*	Combination boring, formed-boring, and chamfering tool
	SEQUENCE OF OPERATIONS FOR SECOND SETTING OF WORK	
1	Load	
2	Rough-turn face *I* and hub *J*	Combination turning tool
3	Face surfaces *K*, *L*, and *M*	Combination facing tool
4	Semi-finish-turn hub *J* and face *I*; chamfer edge *N*	Combination turning and chamfering tool
5	Finish-face surfaces *K*, *L*, and *M*	Combination facing tool
6	Finish-turn hub *J* and face *I*	Combination turning tool

Note: The work is malleable iron, and coolant is delivered to the tools at all stations. For the first setting, the work is held by the hub in three-jaw universal chucks; and for the second setting, the work is dropped over pilots in the holes in the rim and rotated by drivers. Rate of production for first setting, 50 per hour; rate of production for second setting, 136 per hour.

TABLE 3. SEQUENCE OF MACHINING OPERATIONS ON BRAKE DRUM

Operation Number	Operation	Types of Cutting Tools Used
1	Load	
2	Rough-turn outside diameter *A*, Fig. 8, and inside diameter *B*; rough-bore hole *C*	Combination turning and boring tool
3	Rough-face surfaces *D*, *E*, *F*, and *G*	Combination facing tool with cross-feed mechanism
4	Semi-finish-turn outside diameter *A*, inside diameter *B*, and bore *C*; form radius *H*	Combination turning and boring tool, with formed tool for radius *H*
5	Finish surfaces *E*, *F*, and *G*	Combination facing tool with cross-feed mechanism
6	Finish-turn surface *A* and ream hole *C*	Combination turning tool and reamer

Note: The work is held by three-jaw chucks which grip shoulder I. The work is cast iron and is machined dry. Rate of production, 52 per hour.

cial work-holding fixtures which might be required, would introduce such a heavy item of overhead expense that it would be impossible for the jobbing shop to bid successfully for work and include a reasonable margin of profit in its quotations.

Possibility of Running Machines on Several Different Jobs

The situation in the Ford plant and in the jobbing shop constitutes two extreme examples of the application of mult-au-matics. But for each of these extreme cases there are a large number of average shops having work that could be advantageously handled on these machines, and the general statement may be made that wherever pieces can be stocked after machining in sufficiently large quantities to keep a mult-au-matic running on a given job for a considerable period of time, it will be found that the machine will earn a satisfactory income on the investment. The time required to change the set-up of a machine from one job to another does not usually take more than one day, and it is often much less. In some cases, it may appear that an entirely disproportionate amount of time is required for setting up the machine as compared with the actual operating period, but a careful investigation will reveal the fact that this is due to the extremely high rate of production that is attained when the machine is actually placed in operation. For instance, consider the case of a job formerly done on machine tools where the rate of production was 100 pieces in twenty-eight hours. A mult-au-matic was adopted for this job, but only a small part of its time sufficed to produce the required number of pieces. It was found that twelve hours was needed to set up the machine and that only three hours was required to machine 100 pieces. But, although 80 per cent of the time was consumed in setting up and only 20 per cent in operating the machine, it will be evident from these figures that the total setting-up and production time per one hundred pieces is only fifteen hours, as compared with twenty-eight hours by the former method; that is to say, a saving of nearly 50 per cent is made. This instance, however, does not detract from the fact that the mult-au-matic is essentially a production machine, and not a job shop tool.

TABLE 4. SEQUENCE OF MACHINING OPERATIONS ON DIFFERENTIAL DRIVING GEARS

Operation Number	Operation	Types of Cutting Tools Used
1	Load	
2	First roughing cut in bore *A*, Fig. 11	Single boring tool
3	Rough-face surface *B*; rough-turn surface *C*; rough-face half way across surface *D*	Straddle tool provided with cross-feed
4	Face remainder of surface *D*; finish-face surface *B*	Straddle tool provided with cross-feed
5	Finish-face surface *D*; bevel edge *E*	Combination facing and chamfering tool
6	Finish-bore hole *A*	Boring tool carried in floating holder
	SEQUENCE OF OPERATIONS FOR SECOND SETTING OF WORK	
1	Load	
2	Rough-turn face *F*	Single turning tool with angular feed mechanism
3	Semi-finish-turn face *F*	Single turning tool with angular feed mechanism
4	Rough-turn surface *G*	Single turning tool with angular feed mechanism
5	Finish-turn surface *G*; chamfer corner *H*	Combination turning and chamfering tool with angular feed mechanism
6	Finish-turn face *F*	Turning tool with angular feed mechanism

Note: For the first setting, the work is held in a three-jaw universal scroll chuck. For the second setting, a locating plate enters bore A and the work is held down on this plate by clamps. For machining these steel forgings, coolant is delivered to the tools at each station of the machine. Rate of production for first setting, 50 per hour; rate of production for second setting, 84 per hour.

Application of Vertical Drilling Spindle

Three separate gears were formerly manufactured for use in producing the triple gear shown in Fig. 3. After these parts had been completed, they were riveted together into a single unit. Production costs have been substantially reduced by the substitution of a method of manufacture which enables the three parts to be produced simultaneously. Two sequences of operation are performed on separate mult-au-matics to complete the production of pieces of this kind, and the feature of the tooling of these machines in which we are particularly interested is the arrangement of a rotating drilling spindle on one of the tool-heads. This spindle is shown at *A* in Fig. 1. Little thought will be required to make it evident that if an attempt were made to rotate the work at a speed which would enable a one-inch twist drill to cut efficiently, the tool that is turning the outside of gear face *B*, Fig. 3, would be required to operate at an excessively high cutting speed. This would result in the rapid destruction of the tool. Such trouble is effectually overcome by equipping the tool-head with a rotating drilling spindle which receives power from the main drive at the top of the machine. By rotating the drill in this manner, it is possible to obtain such a combination of speeds for the rotation of the work and the drill, that both the turning tool and twist drill will be operated under conditions which enable them to produce efficiently and still avoid excessive wear of the tools.

TABLE 5. SEQUENCE OF MACHINING OPERATIONS ON UNIVERSAL JOINT HOUSINGS

Operation Number	Operation	Types of Cutting Tools Used
1	Load fixture	
2	Bore hole *A*, Fig. 13, and cut away cast flange at *B*	Combination boring and turning tool
3	Ream hole *A* and finish top *B* of open end	Floating reamer and boring tool
4	Rough-turn spherical face *C*	Turning tool carried by pivoted holder
5	Semi-finish-turn face *C*	Pivoted turning tool
6	Finish-turn spherical face *C*	Pivoted turning tool

Note: The work is malleable iron, and coolant is delivered to the tools at each station. The castings are held by the stem in three-jaw universal chucks. Rate of production, 40 per hour.

Detailed Descriptions of Typical Machining Operations

Tables 1 to 5 give a complete summary of the methods of procedure followed by the Ford Motor Co. in machining the parts shown in Figs. 3, 6, 8, 11 and 13 on mult-au-matics. These tables are self-explanatory, but in order to amplify the general description of how machines of this type operate, it will be of interest to take these three pieces and discuss the special facilities furnished for performing the operations which are required on them. Referring

first to the universal joint housing shown in Fig. 13, it will be apparent from Fig. 12, which illustrates a twelve-spindle machine equipped for handling these parts, that at each station around the hexagonal shaped column there are two tool-heads, and twelve work-holding fixtures are mounted around the turret so that two of the malleable iron castings are held at each station. Each casting is held by a three-jaw universal chuck; but to avoid the necessity of closing the jaws tightly enough to distort the hollow stem of the work, advantage is taken of two arms *C* which project out from the casting. These arms have holes drilled in them which make it possible to insert the two pins *D* on the chuck body into these holes to act as drivers.

From the preceding description it will be apparent that during the time that the sequence of operations is being performed on castings carried by the work-holding fixtures on this machine, the operator remains at the loading station shown at the front of the machine, where he is occupied after each index movement in removing two machined castings and setting up two fresh pieces in their places. There are five operations to be performed on this piece of work after loading. Too much space would be required to illustrate in detail the tooling at each station of the machine, and it was impossible to include all of the tools in a single view. However, a description will make the arrangement quite clear, as the illustration shows the tools possessing unusual features of design. Before the malleable iron castings come to this machine, they have to be annealed, and to prevent distortion during this process, the castings are made with a web surrounding the upper opening. At the first station, the work consists of boring hole *A*, Fig. 13, and cutting away the top flange, two combination boring and turning tools being used for this purpose. At the next station hole *A* is reamed and the top opening is finished. At this station the tool-head is equipped with combination floating reamers and boring tools. At each of the three remaining stations, the operation performed is of the same general character, except that roughing, intermediate, and finishing cuts are taken for the purpose of finishing a spherical surface on the work.

A clear view of the tools used for performing the finished spherical turning operation is shown at the right-hand side of the loading station in Fig. 12. Bearing in mind that there are two tools at each station, it will be seen that there are pivoted tool-holders *A* which swing about centers of rotation *B*, the arrangement being such that the effective radius of the tool point is equal to the desired radius of curvature of the work. Secured to the tool-head, which has no vertical movement, there are two racks which mesh with pinions keyed to the back end of pivots *B*, and as the tool-head feeds down, these racks cause rotation of the pinions and thus swing the tools over the spherical surface of the work. As the work is being rotated at the same time that this feed movement of the tools is taking place, it will be apparent that the result is the turning of a perfect spherical surface on the work. After the tools have completed their cut, an eccentric mechanism moves the tool point away from the work before its return movement to the starting position is commenced. This avoids the danger of damaging the finished surface of the work by the back drag of the tool.

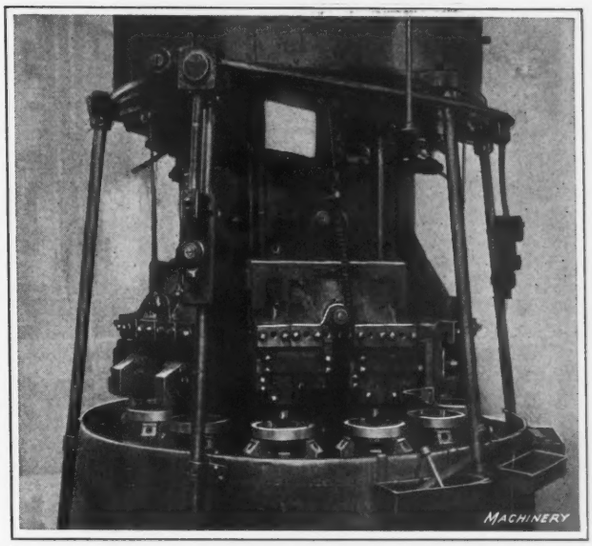


Fig. 7. A Simple Mult-au-matic Job consisting of Plain Cylindrical Boring, Turning, and Facing Operations

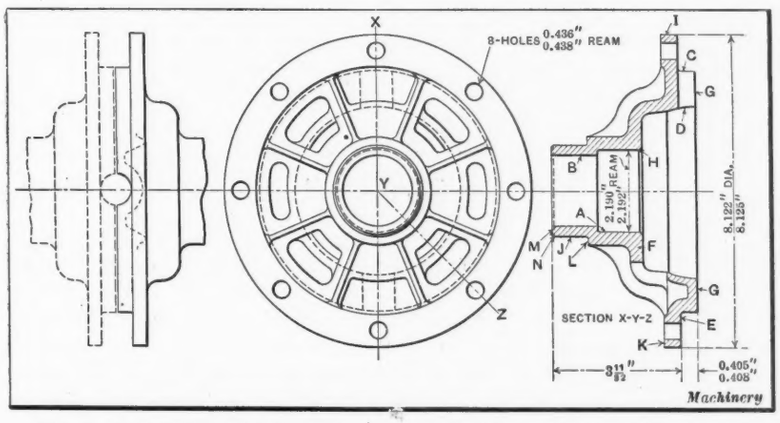


Fig. 6. Ford Differential Gear-case to be machined on Mult-au-matics shown in Figs. 4 and 5

Machining a Piece Using Angular Cross-feed Movements

For machining differential driving gears of the form shown in Fig. 11, it is necessary to employ two machines one of which is utilized for machining all of the faces of the work which can be reached by the tools while the forging is held with its beveled face downward; and after this part of the job has been completed, the work is reset on a second machine with the beveled face upward, in order that the machining operation may be completed. Table 4 gives complete information concerning the machining of these forgings, so that it will be unnecessary to do more than explain the general arrangement of tools and tool-heads at those stations where operations are performed that involve the use of cross-feed movements for the tools. On the first

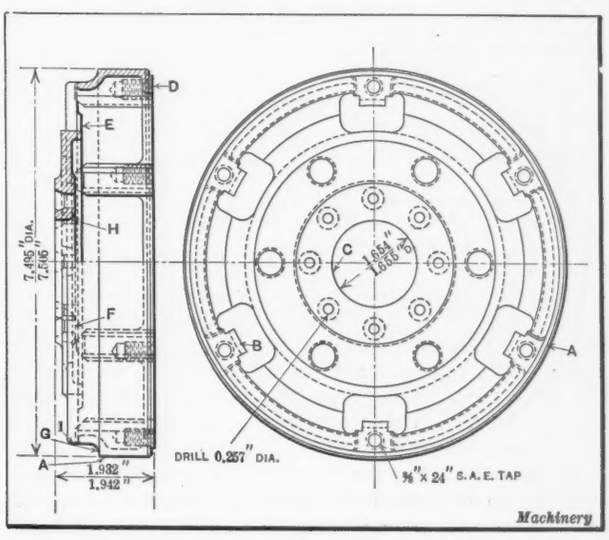


Fig. 8. Ford Brake-drum machined on Mult-au-matic shown in Fig. 7

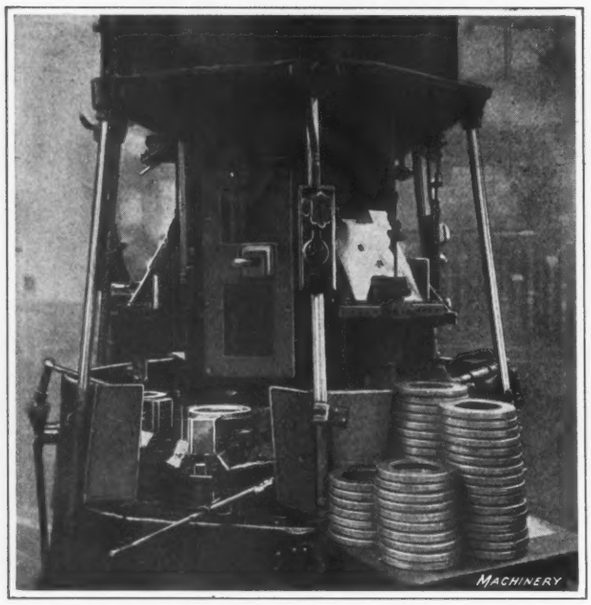


Fig. 9. First Operation on Ford Differential Driving Gears. This Job required some Careful planning by the Tool Designers

machine, the work is mounted with the bevel face downward, as shown in Fig. 9, where it is held by three-jaw universal chucks gripping the forging from its outside. At the first station after loading has been accomplished, the inside diameter *A* is bored, after which the work is indexed to the next station, where the operation consists of facing surface *B*, rough-turning surface *C*, and facing half way across surface *D*.

In connection with this step in the process of manufac-

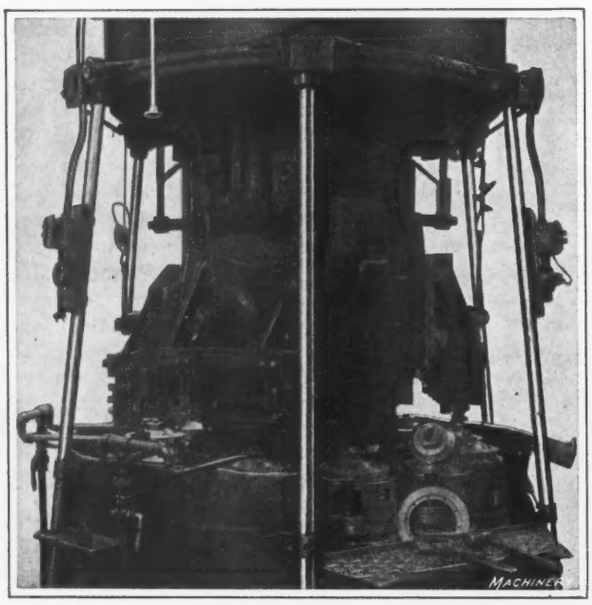


Fig. 10. Second Operation on Ford Differential Driving Gears. The Tools receive an Angular Cross-feed for Turning the Bevel Face

ture, an interesting point is the arrangement of tools for facing surfaces *C* and *D*. A straddle tool is used for this purpose in order that both faces of the work may be machined simultaneously, and the tool that works on surface *D* is mounted with its point slightly in advance of the tool working on surface *B*, so that it will have passed half way across surface *D* at the time that the tool working on surface *B* comes up against shoulder *C*. The facing of surface *D* is completed at a second operation, the idea of dividing this cut being to effect an increase in the rate of production by enabling this long operation to be performed in two steps, at the same time that other operations requiring less time are being performed at other stations on the machine. If this were not done, it would be necessary to hold up the work at other stations until the completion of this long cut over surface *D* had been finished. It will be evident that the straddle tools which face surfaces *C* and *D* must have a cross-feed movement imparted to them. This result is accomplished by a secondary or cross-moving slide, referred to above, to which feed motion is imparted through rack and pinion mechanism when the vertical movement of the tool-head, in its entirety, is brought to rest by contact with its adjustable stop. At this point, as the feed pressure is

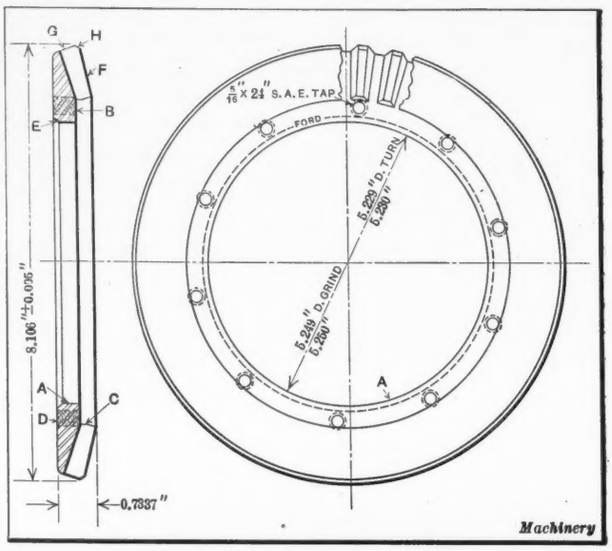


Fig. 11. Ford Differential Driving Gear machined on Mult-au-matics shown in Figs. 9 and 10

continued, a lock-pin connecting the vertical slide to the feed-rod is disengaged and instantly locks the vertical slide in its relation to the positive stop—further movement of the feed plunger actuating the cross movement through the rack and pinion mentioned.

At the completion of the cross-motion cut, the advance feed is changed to a rapid return movement and the tools are passed in a reverse direction through their original path. In this movement of the mechanism, the cross-slide returns to its initial point; the vertical slide is then released from

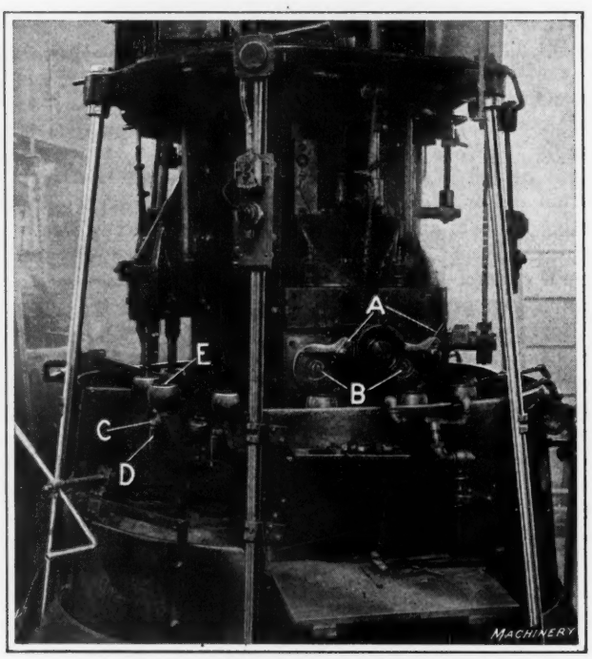


Fig. 12. Mult-au-matic Tool-heads can be designed for turning Irregular Shaped Work. This Machine is equipped for turning Spherical Shaped Surfaces

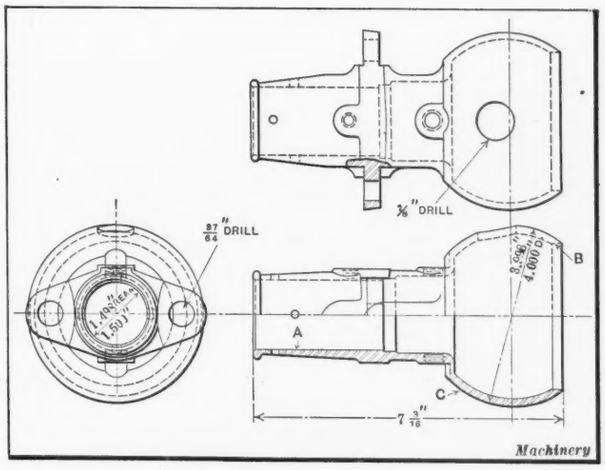


Fig. 13. Ford Universal Joint Housing which is turned, faced and bored on Mult-au-matic shown in Fig. 12

its lock in relation to the stop, the feed plunger is locked in its relation to the vertical slide, and the head in its entirety is returned to its initial position above the work and with the tools clearing it. On the machine used for performing the second sequence of operations, which is shown in Fig. 10, the operations of particular interest are the facing of bevel surfaces *F* and *G*. The mechanism which imparts a feed movement to the tools for handling work of this kind is of essentially the same design as that utilized for imparting a cross-feed movement such as that used for facing surfaces *B* and *D*. The only difference is that the cross-slide on which the toolhead feeds the tools to the work is inclined at an angle, corresponding to the required degree of taper, instead of being horizontal. Surface *F* is faced by employing an angular cross-feed movement of the tools, and surface *G* is faced by the use of an angular vertical feed movement.

Standardized Tool Equipments

It is a basic principle in operating the Bullard mult-au-matic to so plan the arrangement of tools that not only are successive operations being performed simultaneously on pieces of work held at different stations of the machine, but in many cases to also provide for the operation of two or more cutting tools on the work held at each station. This is naturally the means of greatly reducing the time required for the performance of machining operations. Another important feature of mult-au-matic tooling is that practically nothing but single-point turning, boring, and facing tools are used; as the pieces to be machined are often of quite small size, the possibility of simultaneously employing more than one tool to operate on a piece may be made difficult to accomplish through interference of tool-holders or other means which are employed for supporting the tools so that it is not an easy matter to bring them close enough together to reach the desired surfaces. With a view of overcoming these difficulties as far as possible, a large number of standard tool-holders are manufactured, representative examples of which are shown in Figs. 15 and 16.

It will be apparent that these holders are made with a variety of different offsets and insets, which provide for bringing the points of tool bits carried by different holders into close proximity to each other, although the centers of the holder shanks are far enough apart to prevent interference; also, practically all of the bits used in these holders are ground from straight bar stock, which not only saves the expense of forging special cutters, but also reduces both their first cost and the expense of maintenance. In connection with the illustrations of the tool-holders attention is called to the manner in which provision is made for the performance of straddle-facing operations, and for handling other work of a similar nature. The way in which standard tool-holders are arranged for such operations as straddle-facing will be readily understood. At the bottom of the tool-holder there is an offset section in which one of the bits is mounted; and the shank of the holder is splined to receive a collar by which the upper tool bit is supported. There is a key in the collar that fits into the spline groove in the tool-holder shank to prevent it from turning, and a set-screw in the collar enables it to be secured to the shank in any desired position, so that the proper spacing is obtained between the cutting points to provide for facing opposite sides of the work at the required distance apart.

Advantages Claimed for Mult-au-matic Machines

In running a factory under the conditions which exist today, the management is faced with two propositions which vitally affect the policy adopted when there are enough unfilled orders on the books to justify an extension of plant facilities. Conservative estimates of the present cost of

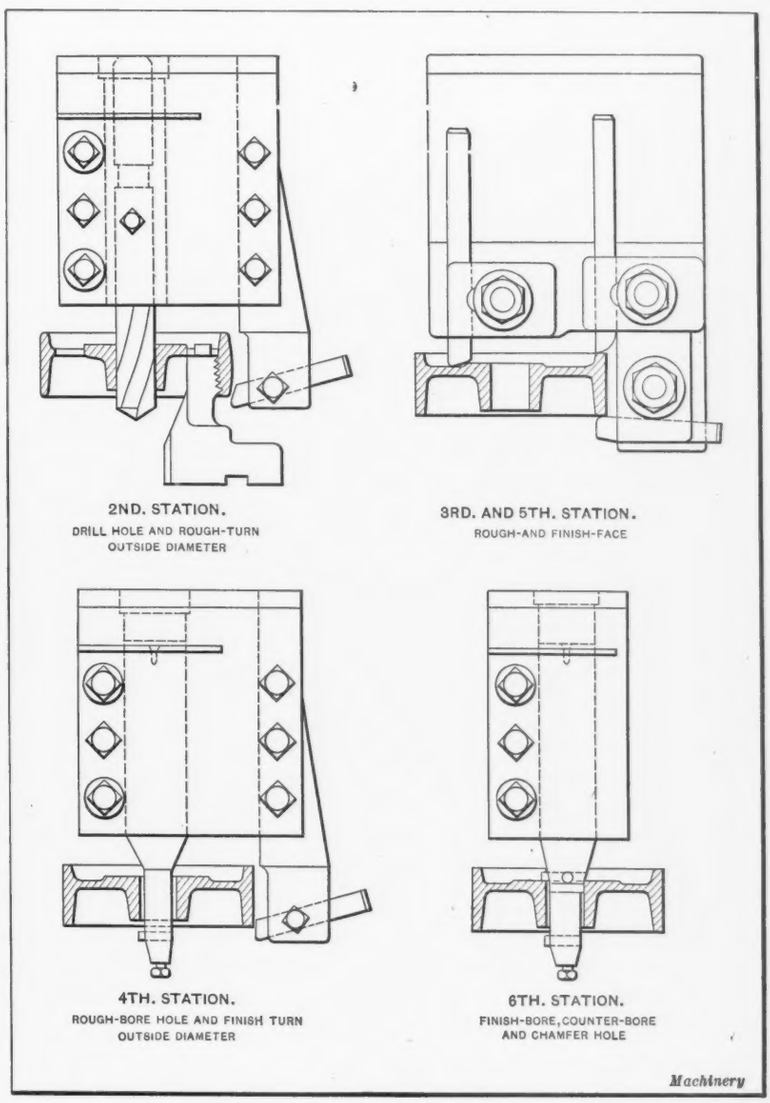


Fig. 14. Tooling of Mult-au-matic and Sequence of Operations in machining Ford Transmission Disk Drum

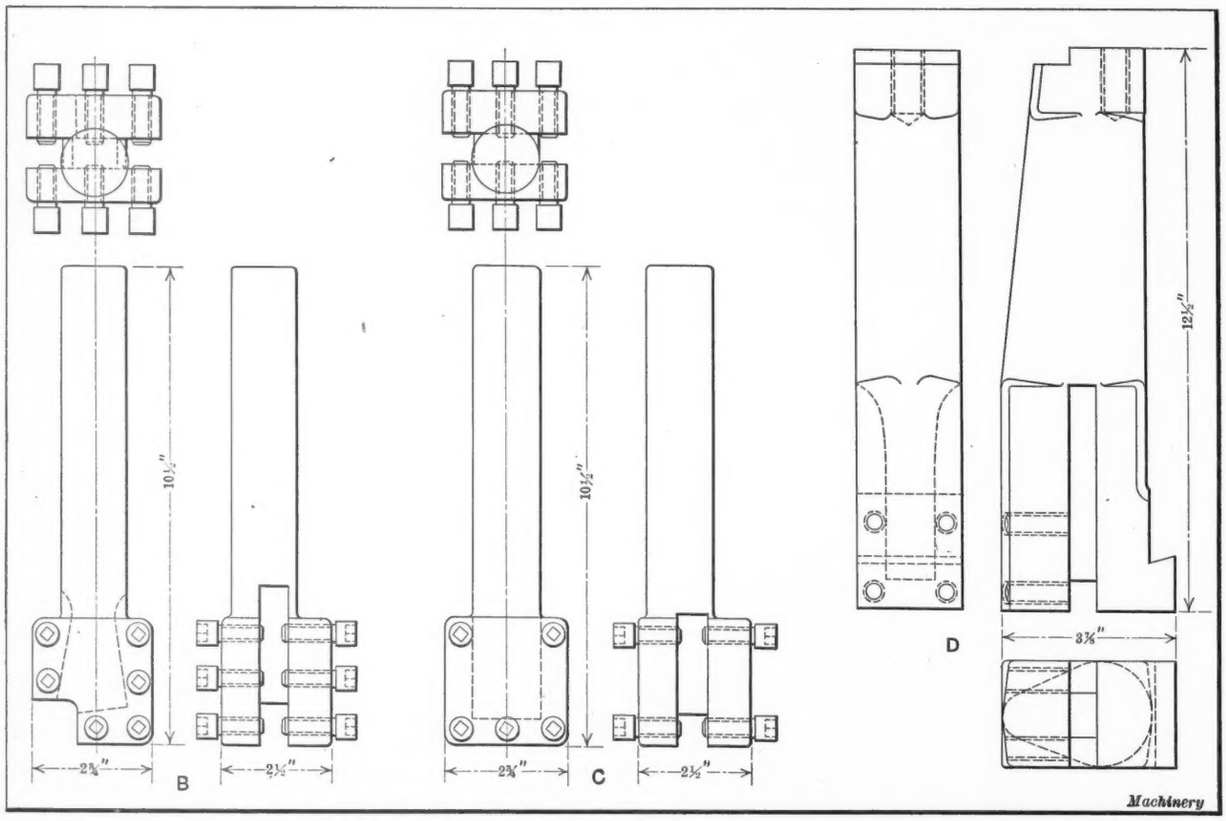


Fig. 15. (B) Combination Tool-holder made in Right- and Left-hand Styles; (C) Universal Tool-holder; (D) Facing Tool-holder made in Right-, Left-, and Combination Right- and Left-hand Styles

building construction make it necessary for those who are erecting new factories or adding to existing plant capacities to provide for writing off at least 50 per cent of the building cost during the next two or three years, in order to compensate for the depreciation in value of the property, which will result from a return of building costs to a figure approaching the normal average. This high building cost necessarily places a serious overhead burden upon work done in a factory put up under present conditions of the labor and material markets; and after the actual work of erecting a new building has been completed, the management of an industry located in many manufacturing centers is likely to experience serious difficulty in securing the necessary number of men to operate machines placed in its new factory buildings.

Not only do multiple machines of this type enable a

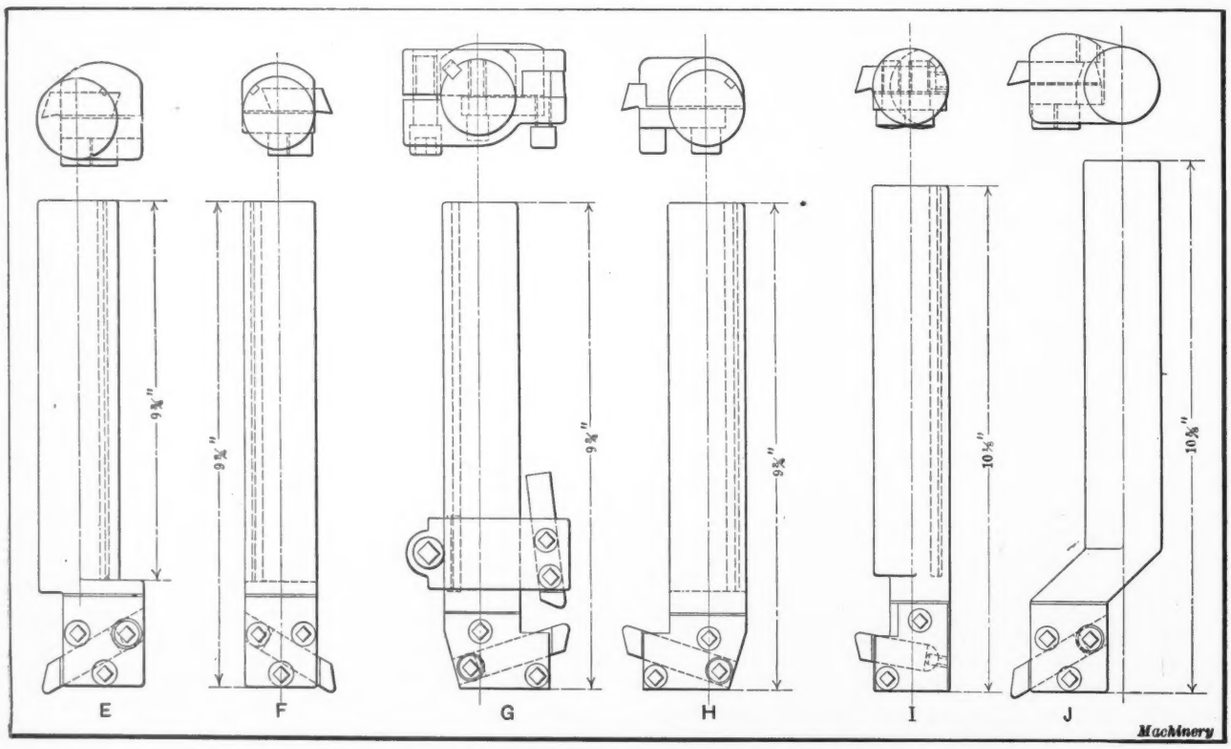


Fig. 16. Typical Examples of Standard Tool-bars, all of which are made in Right- and Left-hand Styles. (E) Inset Boring and Turning; (F) Straight Boring and Turning; (G) Right-hand Under Facing with Straddle Collar; (H) Left-hand Under Facing; (I) Outside Under Facing; (J) Offset Boring and Turning

smaller number of operators, who are assisted by the automatic control mechanism which is provided, to turn out a much greater quantity of product, but the amount of floor space required by the machine is also greatly reduced. Production obtained from a mult-au-matic is augmented by the fact that it is the equivalent of at least six machines whose operations are automatically coordinated, so that no time is lost in removing and resetting the work, or in transferring partially finished pieces from one machine to another. For the same reasons, there is a saving of power due to the elimination of a large percentage of the overhead works and

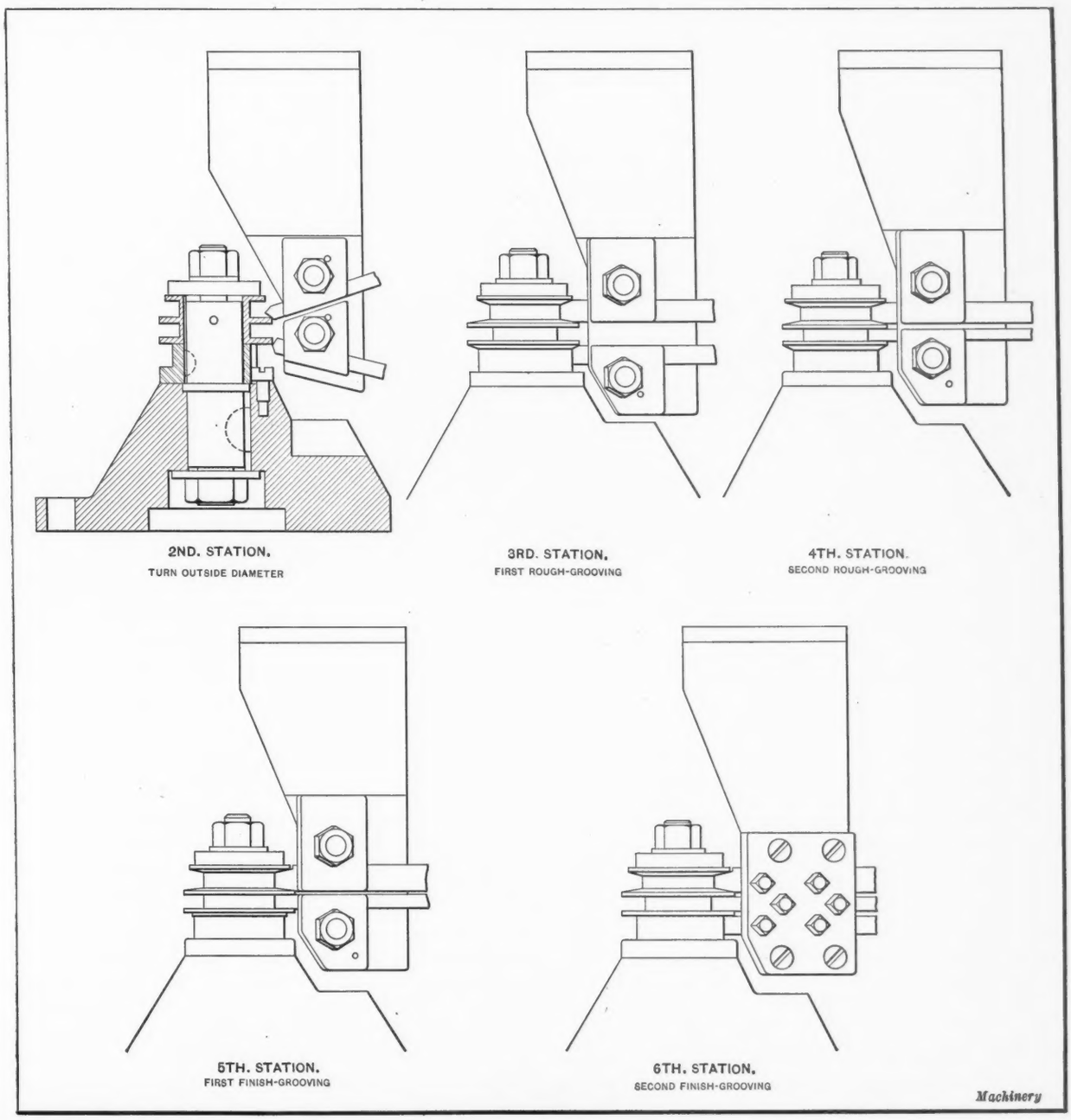


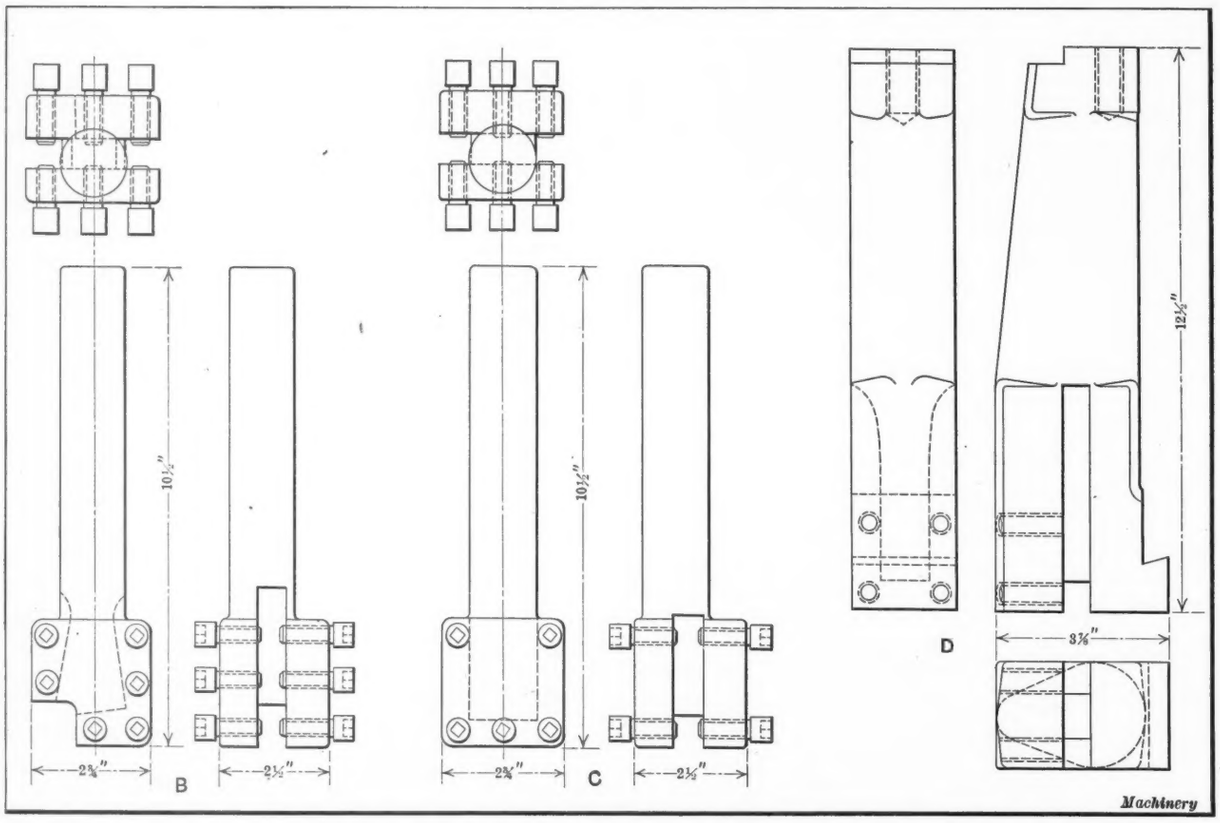
Fig. 17. Arrangement of Tools and Sequence of Operations Performed on Mult-au-matic equipped for machining Ford Clutch Shift

other auxiliary apparatus required to operate individual machines. This freedom from the presence of countershafts, belting, etc., is also the means of doing away with obstructions to adequate illumination.

As regards the actual time required to complete a sequence of machining operations, it may be mentioned that the time per piece is the same as the time required to make the longest cut on that piece, plus the indexing time. This point is of importance not only in estimating the rate of production that could be attained in machining a given piece of work, but also in its effect upon the life of cutting tools used on the machines. Of course it is desirable to increase the speed to the maximum productive capacity of the cutting tools required for taking the longest cut; but the time of operations performed at all other stations may be synchronized with the time of the longest cut, and in this way the severity of service required of tools at all other stations is substantially reduced. Hence, the problem of tool maintenance is likely to resolve itself chiefly into a question of maintaining the tools at that station of the machine where the maximum severity of service is experienced. Naturally it will be necessary to grind other tools, but at less frequent intervals.

How Overhead Charges against the Job are Reduced

Reduction of such production cost factors as floor space, labor, power, tool renewals, and maintenance charges tends to reduce the overhead which must be charged against a mult-au-matic job, as compared with other methods of pro-



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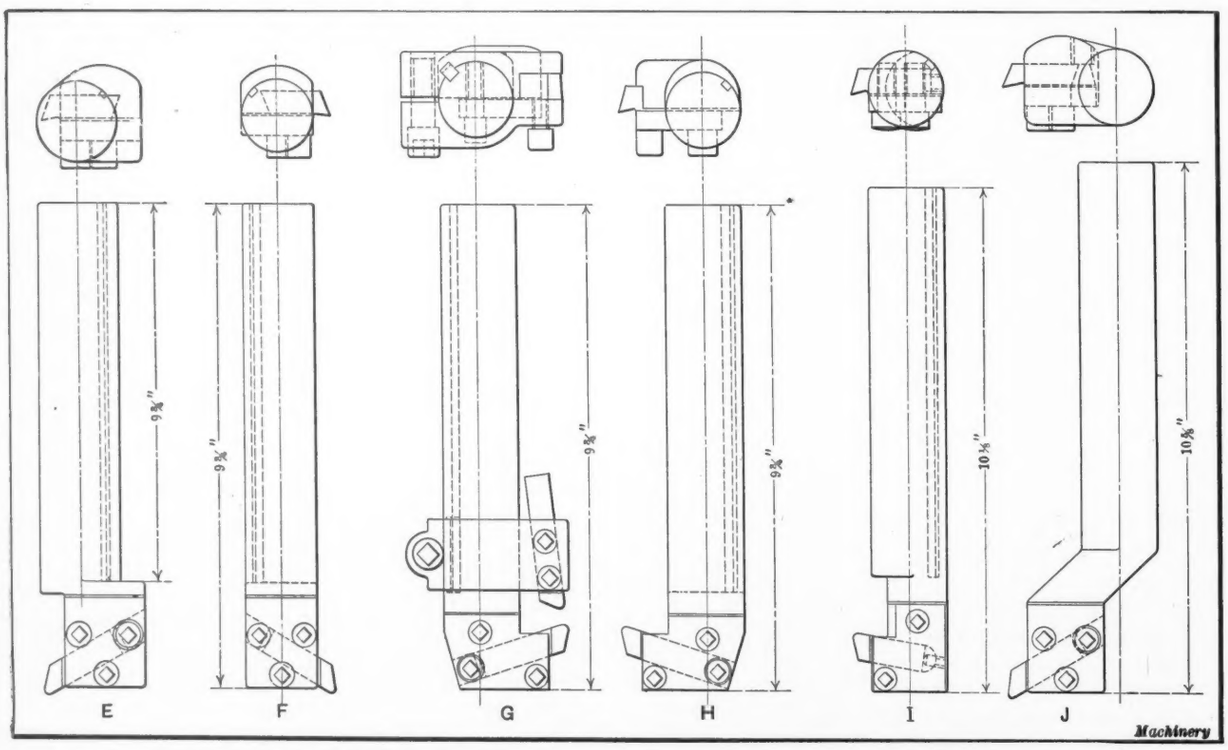

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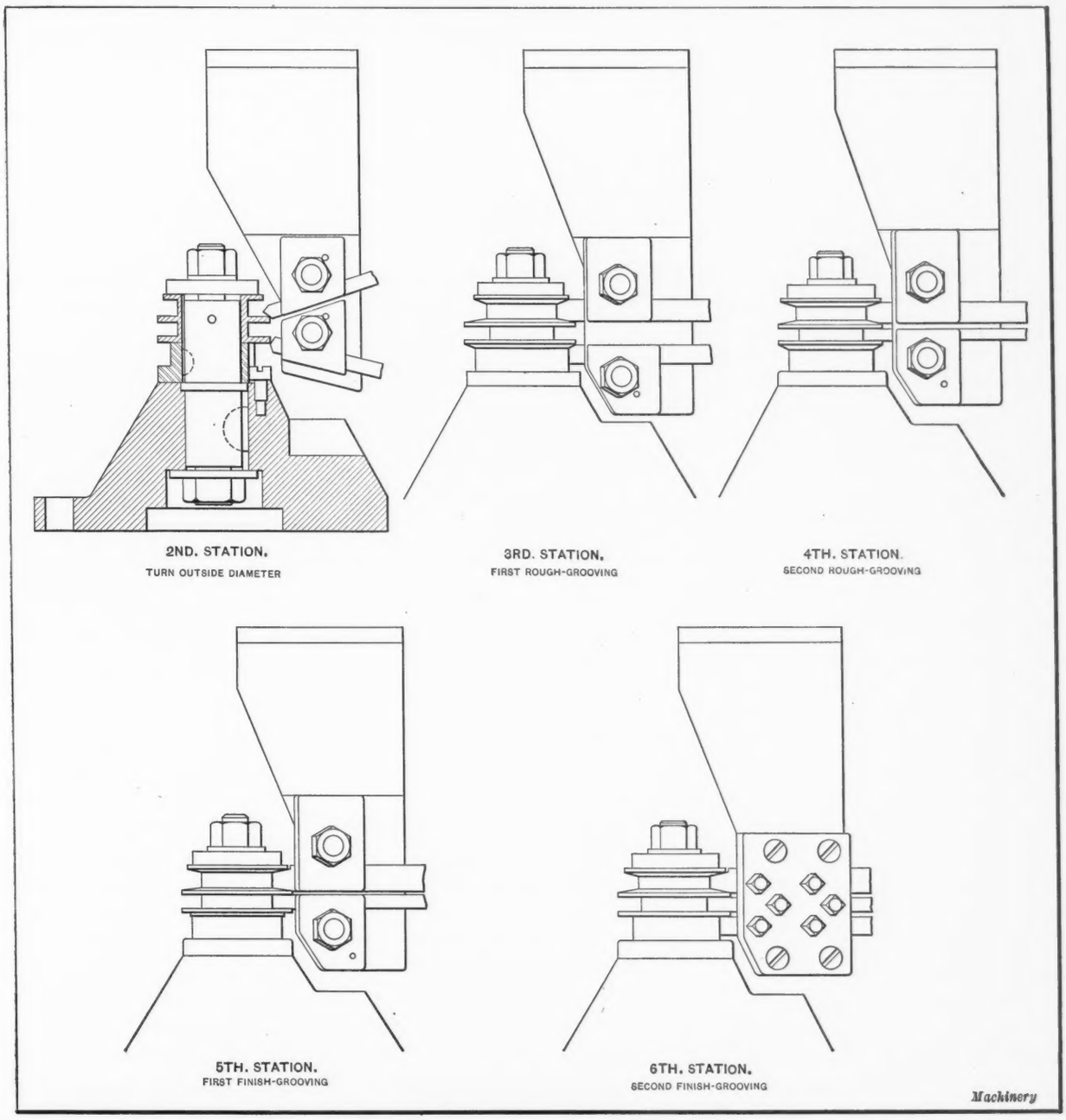

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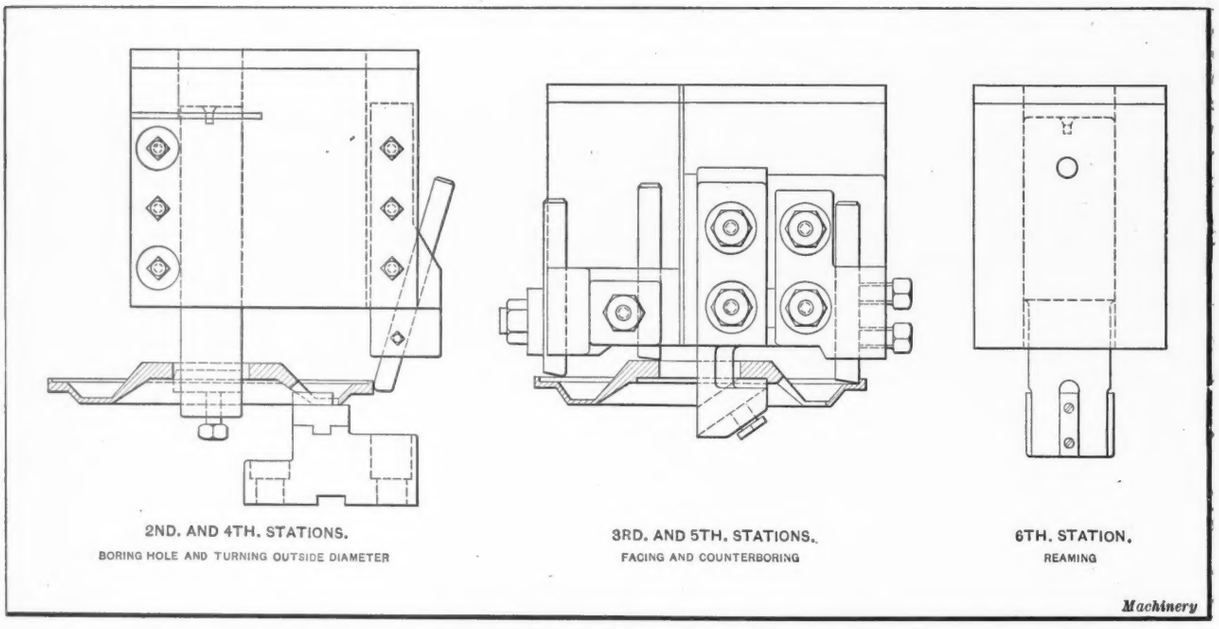


Fig. 18. Mult-au-matic equipped for machining Ford Transmission Driving Plates. Good Examples of the Simultaneous Operation of Several Tools are shown at the Third and Fifth Stations

duction. The cost of supervision is also lower because cutting down the number of workers reduces the number of men who are constantly being hired and trained for the job. In operating a machine of this type, such functions as indexing are performed at a constant speed, regardless of the rates at which the work is rotated and the tools are fed to the work. Each tool-head is independent of all other heads on the machine, and the rate of feed at each station is adjusted to meet the requirements of individual operations. An important feature of the coordinating mechanism is that it enables all movements of the machine to be performed at uniform predetermined rates which are entirely independent of the operator.

Practice of the Ford Motor Co. in Designing Tools for Mult-au-matics

Reference has been made in this article to a large assortment of standard tool equipments which are manufactured by the Bullard Machine Tool Co., for use on mult-au-matics, and it will be recalled that these tools are made with various offsets, insets, etc., to provide for handling practically any job. For plants which make a practice of avoiding the handling of tool work at their own shops wherever possible, the opportunity of obtaining these standard tools is a great convenience. But in a plant having a well equipped toolroom and experienced tool engineers to plan methods of performing machining operations, it will often be found possible to make mult-au-matic tools which possess peculiar advantages for handling special jobs. This practice works out particularly well in cases where the machines are to be run continuously on a single job, which is the method of operation in the Ford plant. Figs. 14, 17, and 18 illustrate the tools and arrangement of machining operations for manufacturing transmission disk drums, clutch shifts, and transmission driving plates. They show the sequence of operations involved in machining these parts more clearly than the photographs of machines equipped for performing the various sequences of operations which are outlined in Tables 1 to 5. These diagrams of the arrangement of tools and operations are also of exceptional interest in that they afford an opportunity of judging the relative merits of standard tool equipments manufactured by builders of the mult-au-matic machines, and standard equipments made in the user's shop to meet the special requirements of his work.

* * *

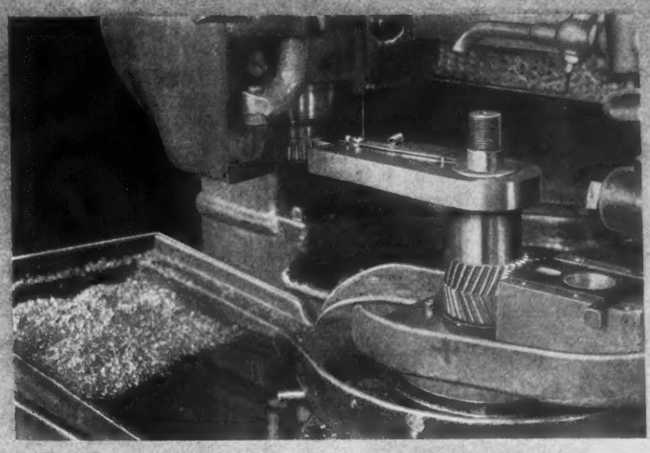
RECOMMENDED PRACTICE FOR TOLERANCES ON HOLES IN GEARS

A committee of the American Gear Manufacturers' Association at the meeting in Boston in October submitted a report which was accepted as recommended practice by the association. Holes in gears are divided into three groups or classes: Class 1 applies to precision gears, such as used in aircraft, printing machinery, etc.; Class 2 applies to gears for automobiles, machine tools, etc.; and Class 3 applies to pumps, hoisting machinery, and general jobbing gears. The recommendations cover hole diameters ranging from ½ to 12 inches. In deciding upon the tolerance and the limits for the different classes of gears dealt with, the accompanying table was worked up. It is believed that these figures, if adopted as representative of standard practice in gear-making and used by all makers of gears, will produce a standard quality. It will be noted that the tolerance of Class 2 is about twice that of Class 1 and that of Class 3 about twice that of Class 2.

LIMITS AND TOLERANCES FOR HOLES IN GEARS

Diameter, Inches	Class 1 Precision-Aircraft-Printing Machines, etc.			Class 2 Automobile, Machine Tools, etc.			Class 3 Standard Jobbing Gears		
	+ Limit "Not Go"	— Limit "Go"	Tolerance	+ Limit "Not Go"	— Limit "Go"	Tolerance	+ Limit "Not Go"	— Limit "Go"	Tolerance
0-½	0.000	0.00025	0.00025	0.00025	0.00025	0.0005	0.0005	0.0005	0.001
½-1	0.000	0.0005	0.0005	0.0005	0.0005	0.001	0.00075	0.00075	0.0015
1-2	0.000	0.00075	0.00075	0.00075	0.00075	0.0015	0.001	0.001	0.002
2-3	0.00025	0.00075	0.001	0.001	0.001	0.002	0.00125	0.00125	0.0025
3-4	0.0005	0.00075	0.00125	0.00125	0.001	0.00225	0.0015	0.0015	0.003
4-5	0.0005	0.001	0.0015	0.0013	0.0012	0.0025	0.00175	0.00175	0.0035
5-6	0.0005	0.001	0.0015	0.00175	0.00125	0.003	0.002	0.002	0.004
8-9	0.00075	0.001	0.00175	0.002	0.002	0.004	0.003	0.003	0.006
11-12	0.001	0.001	0.002	0.0025	0.0025	0.005	0.004	0.004	0.008

Cutting Triple Gears With Accurate Tooth Alignment



Methods Employed to Obtain Accurate Tooth Alignment when Cutting One-piece Triple Gears Having Spur and Helical Teeth of Different Diameters

By CLAYTON C. MARSH, Chief Tool Engineer, Allison Experimental Co., Indianapolis, Ind.

THE manufacturer is often confronted with the problem of cutting one-piece gears such as shown in Fig. 1, which have different kinds or sizes of gears on the same forging or solid blank, and which must have their teeth in alignment. There are many different kinds of gear drives requiring accurate tooth alignment of several gears on one shaft which could be produced much more rapidly and with greater accuracy in regard to tooth alignment, if the practice of cutting such gears from a solid shaft or forging were adopted in place of the usual method of cutting each kind of gear separately, assembling them on a shaft, and depending on keys to hold them in accurate alignment when in use.

When such gears are made in one piece, the chance of their getting out of alignment by slipping on the shaft is entirely eliminated, and they will withstand severe usage such as that imposed on the gear here described and shown in Fig. 1. Among gears of this type that could be cut in one piece might be mentioned automobile transmission gears, machine tool feed gears, and many kinds of gears used in power transmission. This problem has presented itself more often in the production of spiral and herringbone gears than spur gears, although modern spur gear design often demands this construction, especially automobile transmission gearing.

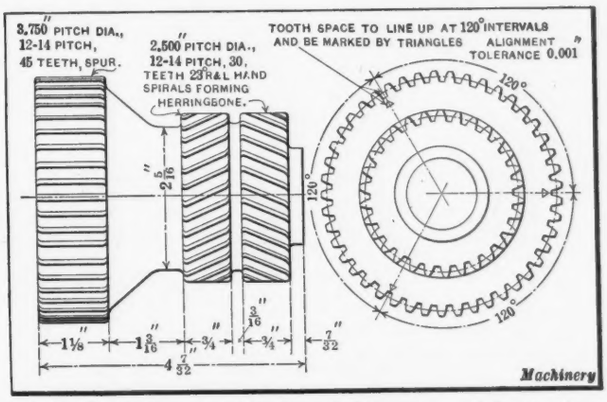


Fig. 1. Triple Gear, showing General Dimensions and Tooth Alignment Requirements

Various manufacturers have used different methods for obtaining tooth alignment with more or less accurate results, but few have attained high production combined with accuracy. To obtain successful operation and smooth running qualities in herringbone gearing, with minimum friction, it is, of course, necessary that the right- and left-hand spiral tooth angles be exactly opposite and in as nearly perfect alignment as possible. One of the common methods of aligning herringbone gears is to cut each spiral as a separate gear, later mounting these on a hub and bringing them into alignment by turning one gear around until the teeth line up, then using either dowel-pins and bolts, or keys, to hold them in position. Cutting a keyway in some definite relation to a tooth does not appear to be a difficult problem, but very slight errors in the location of the keyway are multiplied at the pitch diameter of the

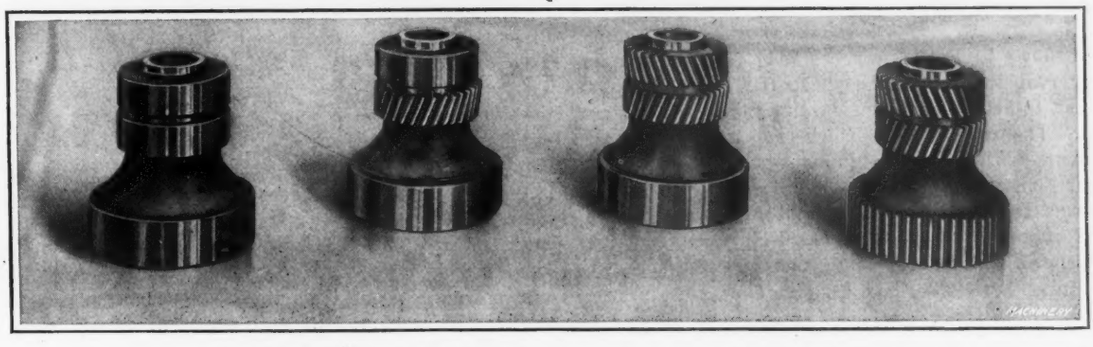


Fig. 2. Blank, and Finished Gear after Each Successive Operation

gears; thus gears made in this way quite often show undue wear caused by incorrect meshing.

When developing a method of producing gears having spur teeth in some fixed alignment with spiral teeth, or when it is required that two or more sets of spur teeth in one-piece gears have their various teeth in alignment with each other, it should be remembered that in rapid production, work set-ups must be made quickly and that the chance for error in setting up must be eliminated in so far as possible. The fixtures to be used must also be capable of repeating the same operation with a degree of accuracy commensurate with the tolerance of tooth alignment of the work.

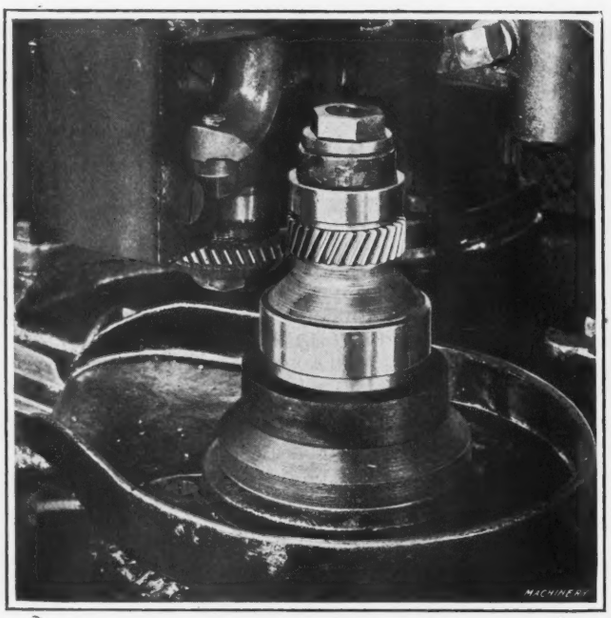


Fig. 3. First Operation—Cutting Right-hand Spiral Gear on Gear Shaper, using Pull Stroke

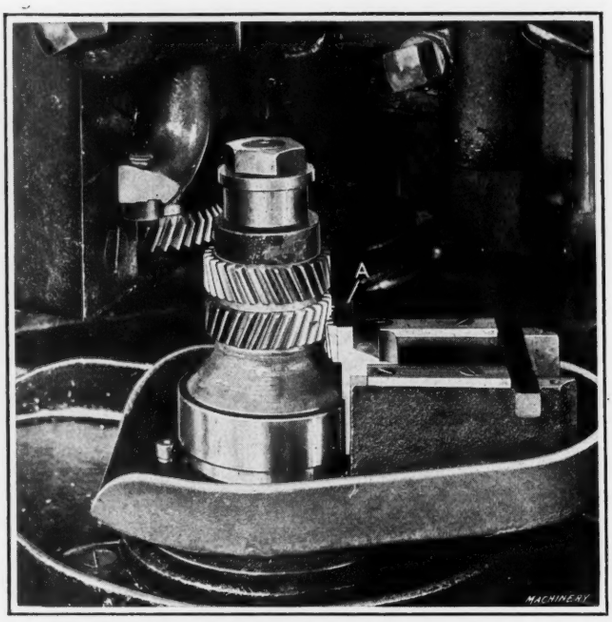


Fig. 4. Second Operation—Cutting Left-hand Spiral Gear on Gear Shaper, using Push Stroke

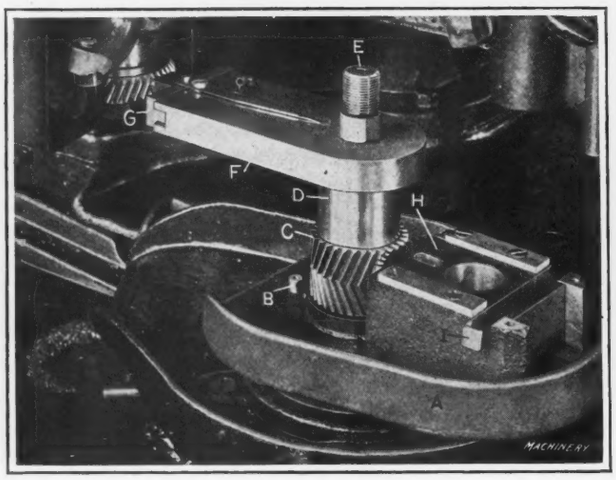


Fig. 5. Method of aligning Cutter for Second Operation

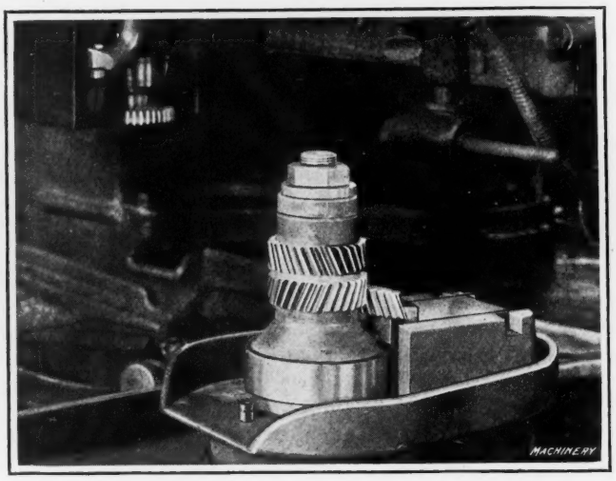


Fig. 6. Work after the Second Operation is Completed

The gear shown in Fig. 1 was designed for and used in a planetary reduction set on the "Liberty Twelve" motor and is subject to heavy load, considerable thrust, and fairly high speed. The requirements called for interchangeable hardened gears with a tooth alignment tolerance of 0.001 inch. After some study of these requirements the tooth alignment was found to be less difficult to maintain than it was first supposed to be. By considering each cutting operation separately, the following method was adopted, and the fixtures here described designed and put in use. By a modification in design of these fixtures, not only spiral, herringbone, and spur teeth could be aligned, but also spur and spiral gears combined with bevel tooth gears could be cut in alignment. These fixtures need not be either elaborate or expensive; the only requirements are that the limit of possible error in them be a little less than the tolerance of the work.

Construction of Fixtures, and Method Employed in Cutting Spiral and Spur Gear Teeth

In Fig. 1 is shown a one-piece gear having a right- and left-hand set of spiral teeth forming a herringbone gear, and also a set of spur teeth. In this case, the two spirals forming the herringbone are of the same pitch diameter, while the spur teeth are cut on a larger pitch diameter. The machine employed to cut this particular gear was the Fellows gear shaper, as shown in Figs. 3 to 9. In order to obtain correct alignment, it was necessary to provide some means of locating the different cutters on the ram in their proper tooth position for cutting the teeth at the large and at the small end of the gear blank. To do this, it was necessary to have some kind of locating fixture which would be adaptable for more than one pitch diameter and form of teeth. The indicating device shown in Fig. 11, used with a sliding segment in the U-shaped casting, is the device finally developed for this purpose.

In Fig. 2 are shown the blanks after each successive

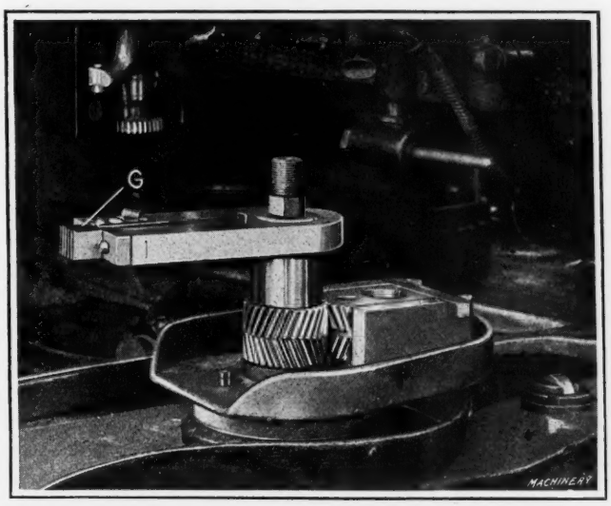


Fig. 7. Aligning Fixture placed on Arbor preparatory to aligning Spur Gear Cutter

operation. At the extreme left is shown the turned blank, uncut. The next view to the right shows the blank after cutting the first spiral or lower half of the herringbone gear. The next view shows the second cut or upper half of the herringbone gear completed, while the last view shows the finished gear after the spur gear teeth have been cut.

The first cut is made without regard to the radial position of the teeth, the blank being held as shown in Fig. 3, which enables the pull stroke to be used. An arbor having the necessary raising plates is used to bring the work into position in relation to the cutter. The first operation consists of making the complete cut to depth. This requires from three to five cuts, depending upon the material, the last cut before the work is removed being but a few thousandths inch in order to produce a smooth finish.

It is now necessary to place the spiral cutter on the ram for the second operation, which is that of cutting the opposite spiral. This cutter must be set so that the alignment between the two spirals will be in accordance with the tolerance allowed on the work. The fixture used to locate the cutter is shown in Fig. 5. The casting *A* which holds the fixture fits over the work-arbor and rotates with it. It is locked to the spindle of the machine by means of a dowel-pin *B*. This pin passes through the casting into the work-table. The casting *A* is made in the form of a pan similar to the apron-pan on the machine, in order to allow the cutting compound to carry the chips into the large pan.

The fixture having the indicator hand is used to multiply the error in setting the cutter. The herringbone gear *C* shown on the indicating fixture is composed of two ordinary spiral gears. These gears were cut on the same machine and by the same cutter that are used later to cut the spiral teeth on the work shown in Fig. 1. They were made from one solid blank which was cut apart after the teeth were formed. After the two spiral gears were aligned by the use of a sine bar, and small pins laid between the teeth, they were locked in position on the sleeve *D* by means of a dowel-pin. The sleeve is turned to fit the bored holes in the spiral gears forming the herringbone. The indicator plate *F* was bored to fit a turned down portion of this sleeve at the opposite end. The end of the plate nearest the cutter was then slotted to fit the tongue in the locating segment *G* that engages the cutter. These sliding segments have approximately five full teeth which is a sufficient number to give full contact with the cutter teeth at the cutting face, the diameter of the top or cutting face determining this. This segment is held in place by shouldered screws that pass through slotted holes, allowing it to slide back and forth the required distance and thus actuating the indicator hand. The action of this slide moves the indicator hand to both sides of a center line intersecting the work-arbor and the pivot of the indicator hand, the latter being pivoted to the main indicator plate in a ratio great enough to multiply the error at least ten times. The indicator hand is slotted

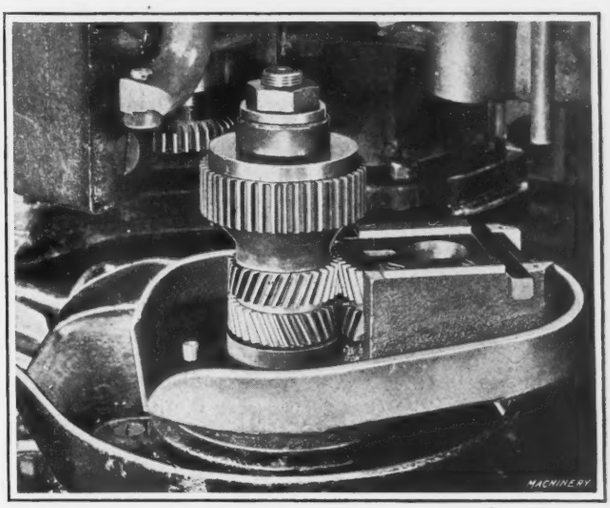


Fig. 9. Third Operation—Cutting Spur Gear Teeth using Push Stroke

to receive the small pin in the center of the sliding segment. The sliding segment is a section cut from a gear having finished teeth cut by the same cutter that is used for the work so that it will engage the cutter itself to the proper tooth depth, thus locating on the pitch line. The bearing surfaces of the tongue in the slide, and the groove in the plate, must be ground and finished smoothly on the sides only, the bottom of the slot allowing a clearance for the end of the tongue, while the sides serve only to keep the segment in line with the plate.

In Fig. 11, the tongue of the sliding segment that engages the cutter can be seen. A space is seen in the slot in the plate in which the tongue fits, the corners of the slot being relieved as well as the corners at the bottom of the tongue in the slide so that the bearing surface is only on the sides of the slot against the tongue and on the ends of the plate against the back of the slide. Three sliding segments, *G*, Fig. 5, are necessary—one for locating the cutter used in cutting the spur gear teeth, one for locating the cutter for the left-hand spiral, and one for locating the cutter for the right-hand spiral gear. The slotted holes in the segment through which the screws pass allow the segment to slide freely. A spring is provided on the indicator hand to obviate lost motion in the slot which engages the slide pin.

In making the indicating fixture, the hand is aligned

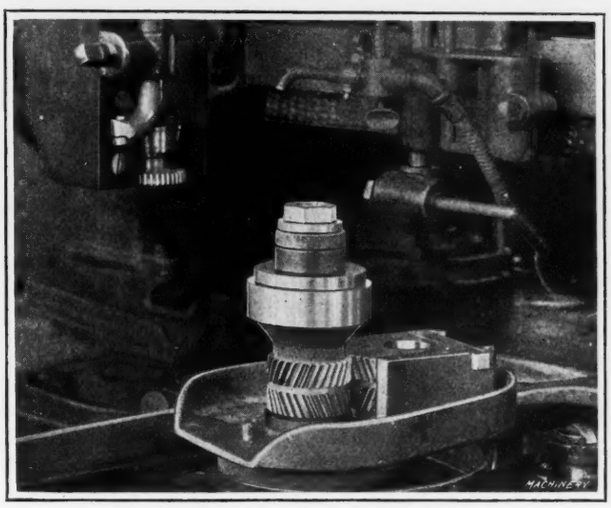


Fig. 8. Work set up in Position for Third Operation—Cutting the Spur Gear Teeth

with the sliding segment and the plate is then doweled to the sleeve, locking both plate and sleeve in a permanent position. The sleeve is shouldered so that the plate rests against this support. The indicator graduations on the plate are made by bringing the hand to a central position which is determined by measuring from either side of the finished plate. The graduations in either direction from the center can be made in accordance with the ratio of the short and long ends of the indicator hand. The indicating fixture is slipped on the arbor, the large herringbone segment *H* in the cutting fixture meshing with the herringbone gear on the indicating fixture.

The large segment *H* was cut from two segments of a driving gear which were aligned in the same manner as were the two spirals forming the herringbone gear on the indicating fixture. The sliding segment used in the casting should have enough teeth to give full contact according to diameter. This segment slides in a machined groove in the cutting fixture casting and is held by two small plates at the top which are fastened by screws. This allows the segment to slide back and forth, and when correctly meshed with the small herringbone gear *C* it is locked by a hardened square key *I* which holds it in a rigid position. It is only necessary for the locking key to bear on the forward side of the slot in the segment, as it will readily be seen that the key cannot move backward when it is in place. The elongated hole shown in sliding segment *H* is merely for reducing weight, and the large hole in the center of the segment is used as the arbor hole when turning as well as when cutting.

Setting Spiral Cutter for Second Operation

For the second operation, the nut which locks the cutter on the ram is first loosened and the cutter rotated until the indicating hand is brought into a central position as shown in Fig. 5. The nut is then tightened, permanently locking the cutter on the ram. The ram is next moved back, and the sliding segment *H* is also moved back, after removing the square key *I*. The apron of the machine is then opened, and the indicating fixture removed from the arbor. After this, the large segment *H* is removed and replaced by the segment shown at *A*, Fig. 4, which meshes with the lower spiral. The work is then placed over the arbor.

The first operation of cutting the lower half of the herringbone gear having been completed, the meshing segment *A* of the cutting fixture, Fig. 4, is moved forward, and the locking key placed in position, thus locking the work in the correct position relative to the cutter on the ram. The locking nut on the work-arbor is then tightened and the apron closed. After this, the ram is moved forward, the first cut set for depth, and the cutting proceeds in the same manner as the cutting of the first spiral, except that the push stroke is used. It must be borne in mind that segment *A* must have the same alignment of teeth as segment *H*, Fig. 5. The sliding segment *A* must revolve with the work, and the engaging segment of this fixture must be low enough to clear the cutter. In Fig. 6 is shown the machine and work

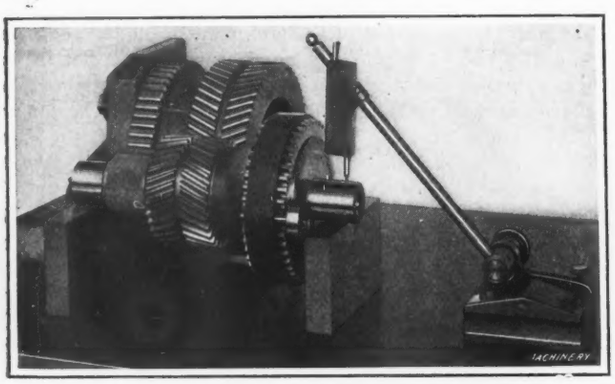


Fig. 10. Method of inspecting Gear for Tooth Alignment

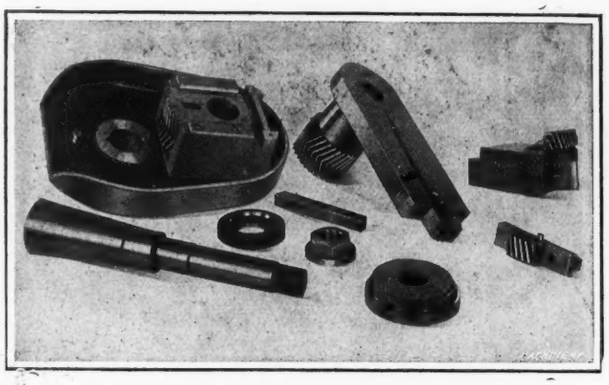


Fig. 11. Work-arbor with Cutting and Aligning Fixtures

after the second operation has been completed. In this illustration the work is ready to be removed.

Cutting Spur Teeth

The next operation is cutting the spur teeth, which must also be in some definite radial alignment with the herringbone gear teeth. Leaving the apron in the machine open after removing the work, the sliding segment in the cutting fixture is changed, the double or herringbone segment *H*, Fig. 5, again being inserted. It is then necessary to change the cutter-engaging segment in the indicating fixture to one having spur teeth as shown at *G*, Fig. 7. The spur cutter is then placed loosely on the ram, the lock-nut not being tightened. The apron of the machine is next closed so that the aligning fixture is in the position shown by the heading illustration, the spur cutter for the third operation being in place and the apron of the machine closed and locked. The nut of the ram is tightened as in the previous operation, locking the cutter in the correct position for cutting the spur teeth. The ram is then moved backward, away from the fixture, the apron of the machine opened, and the indicating fixture removed. The work is next placed on the arbor in position for cutting the spur teeth, being located by the sliding herringbone segment in the cutting fixture, and locked with the square key as shown in Fig. 8. The apron is then closed, the ram moved forward, and set for the first cut, the fixture, of course, rotating with the work as in the previous operation. The necessary number of cuts are next taken with the work held as shown in Fig. 9.

Inspection for Tooth Alignment

In testing the finished gears, it is necessary to have a master herringbone gear drive, which must be a copy of the gear drive used in the assembled unit, and which must be in correct alignment. This is made by using a master of three sections brought into alignment in the same manner as the small herringbone on the indicating fixture, and permanently keyed, or doweled. This master gear has an end ground square with the longitudinal section of the teeth, and is mounted on an angle-plate which is also square with and bolted to a surface plate on which the inspection is made. The arbor which is used in the master gear must have an end of the same diameter as the arbor used in the work. A pair of ground parallels is used to support the work-arbor on which the work is mounted, so that the height of the arbor in the master gear and in the work is exactly the same from the face of the surface plate.

A small gage-pin having a shank ground to a diameter that will engage the teeth at the pitch line is held in a tooth space by means of a rubber band placed around the gear to be inspected. This gage has one end ground concentric with the shank which protrudes from the end of the gear as shown in Fig. 10. The diameter of the large end is also exactly the same as the two arbors used in the master gear and in the work. The work is moved forward on the parallels until it meshes with the master gear, the former having

been placed in such a position that the large end of the gage-pin comes in a parallel plane with the arbors in the master gear and work. A height gage is then used and set so that the plunger rests on top of the work-arbor. Sliding the gage over the large end of the gage-pin and over the end of the arbor in the master gear should show any error in alignment which may exist. The gage-pin can be removed and placed in any position (using the right combination according to the difference in the number of teeth between the diameters) so that in any one of these positions the three arbors should be the same height from the surface plate within the required tolerance. The pitch diameters can be measured by means of pins or wires similar to those used in measuring the pitch diameter of screw threads. This fixture does not insure correct depth of cut; that must be governed by the operator.

* * *

PLANS FOR INDUSTRIAL CENSUS COMPLETED

Special effort is being put forth to make the manufactures section of the approaching fourteenth decennial census the most complete and comprehensive inventory of the nation's manufacturing establishments ever taken. The schedules which will be used in tabulating the information about the country's industrial resources have already been prepared and printed. These schedules will be mailed to every manufacturing establishment in the United States during the month of December, so that factory owners and managers can familiarize themselves in advance with the questions to be answered when the records of the past year's business have been compiled. The questions relate to the calendar year 1919.

In 1914, when the last manufactures census was taken, about 275,000 manufacturing establishments were listed by the Census Bureau. This time more than 300,000 establishments will be sent schedules. In addition to this it is expected that about 50,000 mines and quarries will be reported. The inquiries relating to manufactures, as specified by the act of Congress providing for the census, include the name and location of each manufacturing establishment; character of organization, whether individual, corporate or other form; character of business or kind of goods manufactured; amount of capital actually invested; number of proprietors, firm members, co-partners and officers, together with the amount of their salaries; number of employes and amount of their wages; quantity and cost of materials used in each establishment; quantity and value of products; principal miscellaneous expenses; time in operation during the year; character and quantity of power used; and character and number of machines employed.

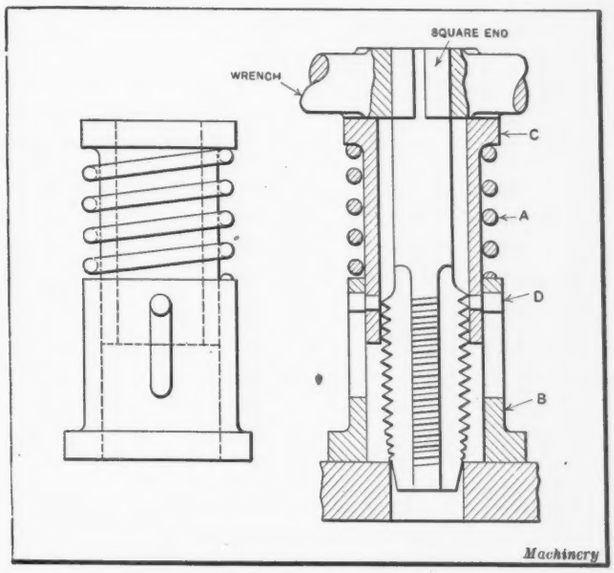
The questions as outlined above will be covered by the general schedule which every establishment will receive. In addition to this a supplemental schedule will be sent to the sixty-eight principal industries as classified by the Census Bureau. This supplemental schedule will allow detailed statistics of output to be set forth under the heading "products manufactured." Census Bureau officials emphasize the fact that all information gathered by the census is strictly confidential, made so by Act of Congress, and is for general statistical purposes only.

* * *

A novel method of grinding surfacer and jointer knives is employed in the carpentry and machine departments of the Danbury Trade School, Danbury, Conn. A beveled block of cast iron is clamped to the planer table. This block is the same length as that of the knives which are clamped to the block with the edges up. An electric grinder is fastened to the toolpost and grinds the knives lengthwise as the bed of the machine travels back and forth. The grinder is carefully guarded so that no emery is allowed to enter the bearings of the planer. The device is said to work very satisfactorily.

HAND TAPPING FIXTURE

The purpose for which the fixture here illustrated was designed is to hold taps at right angles to the work when tapping operations are being performed by hand. This is accomplished through the force exerted by the compression spring *A* against sleeve *B* during the tapping operation, thus holding the sleeve at right angles to the work. This force becomes greater as bushing *C* is drawn into the sleeve when the tap is being fed into the work. On account of bushing *C* being a sliding fit in sleeve *B* and the tap being a running fit in the bushing, these parts are also held at right angles to the work. Bushing *C* is kept from turning in sleeve *B* by the pins *D*, which are driven into the bushing. These pins operate in slots in the sleeve which govern the travel of the bushing. The tap should extend far enough beyond the sleeve to permit it to be inserted into the drilled



Device for holding Taps at Right Angles to the Work

hole so that it will commence cutting the threads when the wrench is revolved. The square end of the tap is held in the wrench by means of a set-screw. C. B. A.

* * *

MOVING PICTURES TO FURTHER TRADE

It has been suggested that South American trade could be considerably furthered by the use of moving pictures. In this way, American manufacturers could show Latin-American buyers how their goods are made, how they are packed, and how they are used. By the aid of moving pictures prospective customers could be taken on a trip through a plant thousands of miles away, and could be even introduced to the heads of the business in the United States by a picture taken in the office of the executive. It is stated that 300,000 feet of industrial film is going to South America every month, but of this amount only 50,000 feet comes from the United States while 250,000 is of foreign origin, being sent mainly from England and Japan to aid the merchants of those countries to get a hold on the South American trade. It is also stated that German industrial organizations are preparing a great number of industrial moving pictures with which the South American market will be flooded at the proper time in an effort to win back good will and business in that market. Efforts are made in the United States to induce our manufacturers to take suitable action along similar lines.

* * *

An association has been formed in England, with Premier Lloyd George as president, to organize at London, in 1921, an exhibition of the industries, inventions, products, and raw materials of the British Empire.

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NEW AND USED EQUIPMENT

After the signing of the armistice, apprehension was naturally felt by American machine tool builders over the possible effect of the sale of a great amount of second-hand machinery by the government, as well as by manufacturers of munitions and war supplies. But the expectation that the government would promptly place large quantities of slightly used machinery upon the market, at greatly reduced prices, did not materialize. If such machines, in considerable number, had been available for immediate delivery some satisfactory transactions would undoubtedly have been made. But unfortunately for those who expected to fill their machine tool requirements from this extraordinary source, numerous delays occurred, and many who waited for the bargains had to wait too long. The books of many such firms would show that failure to realize profits on new business, undeveloped because of the delays in making plant extensions, more than offset any possible advantages in price between second-hand machines obtainable for delivery at an indeterminate date and new machines which could have been set up and put to work without loss of time. The new machines would have paid. It was an after-war experience, without precedent, and if it teaches any lesson at all, it is that our manufacturers, as well as our people generally, go ahead faster and surer when their enterprises are free of government red-tape.

In regard to second-hand equipment, generally speaking, it is probably true that current sales of used machines, tools and appliances do not materially affect the sale of new equipment. On the whole, the second-hand market creates or locates its own clientele, and often aids the builder of new machinery in making the buyer better acquainted with later and more efficient designs, through the sale of used tools which replace still older and less productive equipment in his shop. Some people never buy used equipment, while a very considerable number seldom buy anything else. There is a logical and legitimate market for each class.

* * *

BUILDING A PLANT TO SUIT THE PRODUCT

Unfortunately, a great many machine shops and manufacturing plants are planned by architects rather than by mechanical engineers, with the result that the plant, when completed—while it may be perfect from the architect's point of view and be properly provided with adequate means for lighting, heating, ventilation, and sanitary arrangements—lacks that adaptation to efficient production which should be an item of at least equal consideration with all the other factors.

There are a few notable examples throughout the country where machine shops and manufacturing plants in general have been laid out by mechanical engineers with the view of providing for the proper location of the machinery and the best facilities for transporting materials from one part of the shop to another; and then the architect has been called in merely to provide a roof over and walls around the pre-arranged machinery, and to devise proper lighting, heating, and ventilation systems.

Owing to the complex requirements in the design of manufacturing plants, men who are mechanical engineers and architects in combination have begun to devote themselves exclusively to plant construction. Manufacturers contemplating the building of new plants, or additions to old ones, should not overlook the importance of having the plans made by men who thoroughly understand the mechanical problems involved. The old method of merely deciding upon the addition of so many thousand square feet of additional floor space—and then turning the matter over to an architect—has decreased the efficiency of many a plant by an appreciable percentage. The mechanical engineer should first determine how the machinery and other equipment of the plant ought to be arranged in order to provide for the greatest efficiency in the manufacturing processes; then the task of the architect is a comparatively simple one, and consists chiefly of providing a suitable enclosure for the machinery, which has already been installed, on paper, in its proper place.

* * *

TRAINING OF INDUSTRIAL WORKERS

One of the hopeful signs in the industries today is the increasing tendency toward proper training of men and women for industrial work, so that they may be able to perform their given task more efficiently than formerly. In the past, in the machine industries, very little special training was given to any of the employes, unless they were apprentices. They were expected to find out for themselves how the machining of a certain piece of work should be performed. They were not always properly instructed in the use of the machines that they operated, and, on the whole, no care was taken to insure maximum production. If a man failed to make good, he was merely dismissed, and another hired in his place. The second man often had no better qualifications than the first, and without proper training both were costly to their employers.

The larger plants in the country have now undertaken to hire their help with considerable care, so that the applicant's ability and inclinations are likely to fit in with the work for which he is hired. In addition, special training departments are installed in which newly hired help is properly instructed in the best methods for performing the work to be done. It has been estimated that out of a total of 10,000,000 workers in all the industries, only 3,000,000 are properly qualified by virtue of previous training or apprenticeship to perform the operations comprising their work with any approach to maximum efficiency.

In plants where training departments have been installed, it has generally been found that the productive capacity of the specially trained employes greatly exceeds that of the untrained worker; in fact, new employes, properly trained, have excelled men of longer experience in the trade, who have received no special instruction and who have, therefore, largely worked out their own methods.

The Importance of Engineering Science

By NIKOLA TRBOJEVICH

IT seems unnecessary to say that there has been no time in the history of mankind when the rate of scientific progress, and particularly that of the applied sciences, such as engineering, has been so high as at present. One year, now, when expressed in terms of actual and tangible achievements, means more than did ten years, fifty years ago, and perhaps a century, a thousand years ago. Think of the wonderful results achieved during the past year—the crossing of the Atlantic, both by airplanes and dirigibles; the wonderful developments in the wireless telephone and telegraphy, the telephone amplifier and scores of other things, perhaps less well known, but equally as important. It would be an error, however, to judge the progress of technical science merely by the number of these outstanding or spectacular inventions and applications. It is the condition and the vitality of the great economic body of the world that is of principal interest. This vitality is the soil from which all the inventions have sprung.

We are living in an age in which the development of important inventions and the new applications of scientific principles indicate the beginning of a new era in the life of humanity and a period of enormous expansion in all fields of human endeavor. Mankind is saturated with latent energy seeking an outlet. There is a universal desire everywhere to *act* and to *accomplish* things. The engineers are greatly responsible for this feverish state of mind of the whole world. It was they who taught the people how to get the most out of their labor. They have showed, for instance, how it was possible to assemble a complete chassis of an automobile from hundreds of component parts in slightly more than one hour and a half of one man's time, and how to make it possible for a single operator to spin more yards of cotton thread in a day by the use of automatic machinery, than a thousand workers could spin in a week, by hand work alone.

The adaptation of scientific principles in different trades to the production of goods is the primary field of the engineering science. The application of such principles tends usually either to increase the production or to improve the quality of the product, or both. The engineer's duty is to devise the material means by which to satisfy the demands for greater production or higher quality.

The student of modern history and sociology soon becomes aware of the fact that engineering, being the foundation of material welfare, is the most important of all sciences. Essentially, it is the science of producing wealth. Most of its results are achieved by some labor-saving device, because the rate of production can only be increased in two ways: either by working harder and longer, or by increasing the efficiency of manufacture by adopting suitable machinery, etc.

The progress of humanity may be compared with the motion of a ratchet wheel. It can only go forward; the methods of production are constantly improving, and the intrinsic price of goods as expressed in labor necessary for its production is decreasing. The term "intrinsic price" does not mean the price in dollars and cents, but the amount of labor which is consumed in the manufacture of the article. The increase of production, coupled with the decline of the intrinsic price, tends to raise the standard of living of all classes.

It is the nature of the human race to take any advancement or improvement of its living conditions as a matter of course, but to deeply resent any lowering of them, irrespective of the cause. Every widespread lowering of standards results in dissatisfaction. The latest developments in some parts of Europe, for instance, are the result of a lowering of the living standard, due to war. Here is where the engineering science actually becomes humanity's greatest asset, affecting the course of our whole economic life. The intrinsic price of goods must be lowered in order to create a surplus, and this can be done by engineering coupled with the willingness of workers to work. So long as the engineers are able to improve on their methods and increase the efficiency of processes, there will be a reservoir of energy to draw upon in order to satisfy the steadily increasing demands for a higher standard of living, provided the processes are properly utilized by men at work. The world is in a sort of dynamic equilibrium, and our safety lies in the velocity of our progress.

Now, the question is, how to make progress in engineering? The answer is, by cooperation and by specialization. Genuine progress is only possible by combining a highly developed cooperation with specialization. The specialist will originate a new method, a new device, and the community will give body to the new idea by adopting it, or giving it a fair trial, at least.

In the field of engineering, the amount of knowledge we already possess is so vast as to make it physically impossible for any one individual to become an expert, in the true sense of the word, in more than a comparatively small domain of that immense field. The capacity of the human brain to absorb details is limited. The only way of producing results is to use one's mental capacity, concentrated upon the essential points of a chosen field and leave the rest for the experts in other fields. We cannot increase our individual productive ability above a certain extent, due to our obvious limitations which are of physical and physiological character, but we can increase our efficiency for producing valuable results by coordinating ourselves with others.

The engineering science even in its present state of development, and much more in its truly unlimited future possibilities, is the greatest treasure humanity possesses. Any condition which does not favor the fullest possible development of the sciences in general, and in particular of the engineering science, carries in itself the germs of ultimate self-destruction. The dual principle of specialization and cooperation lies at the bottom of all our progress. Our future development will be exclusively determined by the degree of application of that principle.

* * *

WARTIME CHANGES IN WAGES

The National Industrial Conference Board, 15 Beacon St., Boston, Mass., has issued a bulletin giving a review of the changes in wage rates from September, 1914, to March, 1919. The following is a summary of the report: Average wages of men in eight leading industries, including the metal industry, as measured by average hourly earnings, increased all the way from 74 to 112 per cent during the period from September, 1914, to March, 1919. Increases in weekly earnings of men ranged from 62 to 110 per cent. Percentage increases in earnings of female workers were similar in the respective industries. The increases shown were in most cases greater than the corresponding percentage increase in cost of living, which was placed by a previous report of the National Industrial Conference Board at 61.3 per cent for the period July, 1914, to March, 1919.

American Machine Tools in Spain

By RAMON CASALS, Barcelona, Spain

While Spain is not an industrial country of the first rank, there are nevertheless a number of machine industries in the country, and a considerable quantity of machine tools have been imported in the past, mainly from Germany. The author of the present article, Ramón Casals, a Spanish engineer, who has had a varied engineering experience in the mechanical field in Spain, France, and the United States, and who is now contemplating the selling of American machine tools in Spain, believes that, after the war, there will be a great industrial development in Spain, and that there is a possibility of replacing the German machine tools with the American-made product, provided American machine tool manufacturers are interested in this field.

WHILE Spain does not offer the opportunity for the sale of machine tools that some of the more industrial European nations do, the country, nevertheless, has a number of machine shops for the manufacture of quite a varied product, and there is a fair field for the introduction of American machine tools. Previous to the war, most of the machine tools used in Spain were obtained from Germany, mainly because the Germans sold cheaper grades of machines and offered easier terms to their customers. The Spanish machine shops are nowhere nearly as highly developed as those of England, France, and Germany, and the machine tools most commonly used are lathes, planers, and drilling machines. The methods employed are quite old-fashioned. A great deal of work that is done in the United States by the aid of machine tools is done in Spain by filing or by chipping, the chisel being used in many plants, for example, for the cutting of keyways and for similar work. There is, however, a market for a standard line of machine tools, and if the more highly developed specialized machine tools could be properly demonstrated in Spain by American demonstrators, who thoroughly knew their business, it is likely that they could also be introduced. There is, further, a field for the American type of bench vise, the vises used in Spanish machine shops being of a very old-fashioned type. There is also a great market for files and small tools.

Review of Spanish Industries Using Machine Tools

While none of the industries in Spain is large in the American sense of the word, there are, nevertheless, factories manufacturing a varied line of machinery and products in the making of which machine tools are used, including automobiles, electrical machinery, aviation motors, locomotives, steam engines, railway cars, refrigerating machinery, flour mill machinery, agricultural machinery, pumps, mining machinery, textile machinery, and appliances and devices used on board ships, together with woodworking machinery, scales, and ordnance. The best known automobile plant is "La Hispano Suiza S. A."; but there is also the plant of "A. Elizalde," building an automobile well known in Spain. These were the only two factories for automobile building in Spain at the beginning of the war, but now there are not less than seven automobile factories, all located in Barcelona.

Quite a large plant for the building of locomotives and steam engines is located in Barcelona, as well as works for the building of pumping machinery. In one section of Spain, there is a large textile industry and all the textile mills have their own repair shops for which machine tools are required. The railroad repair shops, of course, are also prospective customers for machine tools. There are several shops devoted to gear-cutting, and gear-cutting machinery should have a fair market in Spain. There are also some screw products companies making use of automatic screw machines, but apart from these shops, automatic screw machines, grinding machines, milling machines, highly developed turret lathes, boring mills, and other machine tools, not in the simple lathe, planer and drilling machine class, are not generally in demand. These classes of machines can be sold only if they are properly introduced and their advantages thoroughly demonstrated to the buyer. The shipbuilding industries have been considerably augmented during the war, there being in Spain, at the present time, seventeen shipyards, the most important ones being the "Astilleros del Ferrol," at Coruna; "Astilleros de la Carraca," at Cadix; "Astilleros Cardona," at Barcelona; and "Astilleros Escalduna S. A.," at Bilbao, where ships up to large tonnage are constructed.

In the ordnance field, there are from thirty to thirty-five factories making firearms, guns, and other ordnance of this class, the most important ones being the "Fabrica de Artilleria de Truvia," at Asturias; "Fabrica de Armas," at Oviedo and at Sevilla; "Garate, Anitua y Ca," at Eibar (Guipuzcua); "Beristain y Ca.," at Eibar; and "La Industrial Orbea," at Eibar.

There are also several important firms making locomotives and railway cars, among these being the "Material para Ferrocarriles y Construcciones," at Barcelona, and "Maquinista Terrestre y Maritima," at Barcelona, where from 1500 to 2500 workmen are employed.

Old-fashioned Methods must be Changed

Too much emphasis cannot be laid upon the fact that the old-fashioned methods used in Spanish shops make it difficult to sell the most highly developed types of American machine tools. Neither the superintendents nor the foremen, not to speak of the workmen, understand the operation of the newer types of machine tools, and the owners of the plants do not appreciate the value of these tools, nor the increased production possible when these machines are properly operated. Ordinarily, if such machines were sold to Spanish shops, they would not be profitable to the buyer because the ordinary Spanish workman would not operate the machine to its best advantage, on account of never having received the proper instruction in the use of these machines. American demonstrators, thoroughly familiar with the use of the machines, who can go into the shops and train the men and show them how greater production can be obtained are, therefore, necessary, if these types of machines are to become commonly used in Spain.

Past Imports of Machine Tools into Spain

The imports of metal-working machinery into Spain from the United States in 1913 amounted to $109,624, which, of course, represents a comparatively small amount. However, there has been a steady increase since 1909, when the value of the imports was only $23,000. On the other hand, the imports from Germany in 1913 amounted to from $480,000 to $500,000, which shows what a big proportion of the trade Germany obtained. During the war, conditions were abnormal, but in 1917 the imports of metal-working machinery into Spain from the United States rose to nearly $1,700,000, and in 1918 the imports were $1,250,000. During the month of May, this year, the total imports of metal-working machinery into Spain from the United States amounted to about $93,000. Of this amount, however, only about $32,000

represented machine tools. It is not possible to state the amount of machine tools represented by the figures for metal-working machinery in past years, because separate statistics of machine tools were not prepared until 1918. In that year, over $350,000 worth of machine tools were imported. The difference between this figure and $1,250,000 is represented by other kinds of metal-working machinery.

Competition that American Machine Tools Must Meet

The figures given relating to the past German imports of machine tools into Spain indicate the competition that may be expected from Germany when that country again begins to become a factor in international trade. England will also doubtless attempt to get some of the Spanish trade, but as England has had very little of this trade in the past, it will be more difficult for the English to introduce their machines in Spain than it will be for the American machine tool manufacturer.

The native competition is not likely to be important. There are, at the present time, about a dozen firms in Spain who make machine tools, but only six or seven of these make machine tools exclusively, or have separate departments devoted to this line. The machines manufactured are largely designed along American or German lines. The machine tools built are of simple types and include only lathes, planers, milling machines, shapers, drilling machines, and turret lathes. All of the shops making machine tools are quite small. It is evident, therefore, that the native competition need not be considered as of great importance.

The most important factors to be taken into consideration are price, delivery, and terms. American machine tool manufacturers can sell their product at a higher price than German machine tools, because they are acknowledged to be of better quality. Delivery, however, must be prompt and the terms must be made to suit the customers' needs, the same as those that are offered by other European competitors. American machine tool manufacturers cannot expect always to be paid in cash upon the delivery of their machines on board ship in New York harbor. If they persist in requiring this, they will seriously curtail their European trade and will work to the advantage of the German machine tool builders, who will be able to sell an inferior quality of machines in the Spanish shops, because of the long credit terms that German machine tool builders have been in the habit of giving their customers.

* * *

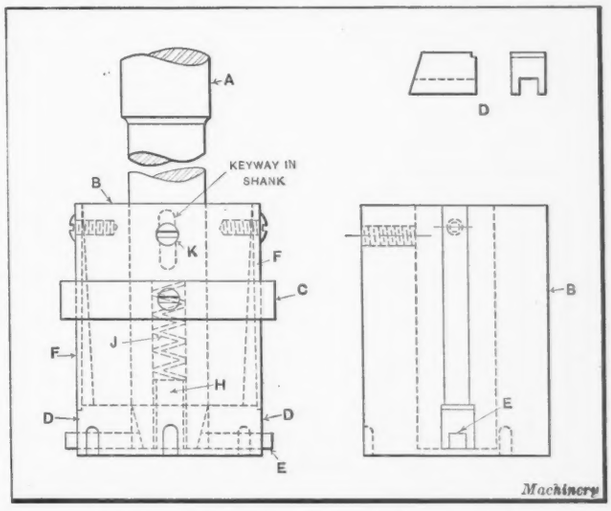
The most refractory metals are used in connection with the manufacture of filament electric lamps. Of these metals tungsten is the most refractory and is the one now in use in lamps. Tantalum, molybdenum and osmium are also very refractory. Tungsten is produced in the form of powder by the reduction of its oxide. This powder can be molded into rods, crucibles and other forms, and sintered by heating to 1800 to 2000 degrees C. The material produced in this way is very porous. Compact ductile tungsten, suitable for the drawing of wire for lamp filaments, is made by hammering the porous material, with suitable heat-treatment. Metals of the platinum group are all refractory. Platinum is used for crucibles, thermocouples, resistance thermometers, electric heaters, and other purposes. Electric furnaces with platinum heaters may be used at temperatures up to about 1500 degrees C., though it is commonly not advisable to approach very close to this limit. Laboratory furnaces with iridium heaters have been used in a few instances, but they are very expensive. They give temperatures up to about 2000 degrees C. The advantage of platinum and iridium heaters over the cheaper graphite heaters is that they can be used in contact with air, while graphite heaters would burn in air and must be used in a vacuum or in a non-oxidizing gas. Graphite produces reduction or contamination in many materials which it may be desired to heat. Some base metals, especially alloys containing chromium and nickel, are used for electric heaters at moderate temperatures.

RECESSING TOOL FOR DRILLING MACHINES

By WILLIAM KELLER

The recessing tool shown in the accompanying illustration was designed to be used on drilling machines for cutting an internal recess to provide a working clearance when tapping holes. The shank *A* of the tool has a standard Morse taper at one end and is tapered off sharply at the opposite end. The straight part of the shank is a sliding fit in the body *B* and is held therein and kept from turning by means of a screw *K* which engages a keyway in the shank. The lower end of the shank is bored out to receive the coil spring *J* and the plunger *H*. It will be noticed that the hole in the body does not pass clear through, and also that a rectangular hole is broached through the body near the bottom, intersecting the shank hole. In this rectangular hole, the two cutter-holders *D* (a detail of which is shown in the upper right-hand corner of the illustration) are a sliding fit. Two slots are milled diametrically opposite each other in the body, directly above the rectangular holes, in which two flat springs *F* are fastened by means of machine screws. These springs engage shoulders cut in the cutter-holders *D*. The adjusting collar *C* fits the body of the tool, and may be fastened to it so as to determine the location of the recess.

The operation of the tool is as follows: In its normal position, that is, when the tool is not at work, the body will be forced down by spring *J* working against plunger *H* as



Internal Recessing Tool for Use on Drilling Machines

far as the screw *K* will allow it to. This brings the lower end of the shank almost to the top of the rectangular slot in which tool-holders *D* are assembled, allowing the springs *F* to slide these holders toward the center of the body, and consequently forcing the tools below the surface. This allows the body to act as a pilot and enter the hole to be recessed until the collar *C* rests on the top surface of the work. The continued downward movement of the shank brings its tapered end in contact with the tool-holders, forcing them radially outward and cutting the recess at this point. While the recess is being cut to the required depth, the coil spring *J* becomes contracted and the force thus exerted on plunger *H* will hold the body in place at the completion of the operation until the spindle has been raised sufficiently to allow the springs *F* to withdraw the cutters from the recess. The continued upward movement of the drilling machine spindle will cause the screw *K* to be engaged in the lower end of the keyway in shank *A*, so that the body *B* will be withdrawn from the hole. The tools bits *E* are made of high-speed steel and are forced into the holders *D* and peened, so as to be held in place, and the ends ground at an angle to fit the end of the shank.

Special Pattern Work

Use of Stopping-off Pieces—Core and Strickle Work—Skeleton Pattern Work—Match-Plate Work—Loam Molding

By JOSEPH A. SHELLY

THERE is more or less specialization in the different branches of the patternmaking trade. This specialization has developed from the efforts that are constantly being made to produce castings with a minimum amount of pattern work or with greater rapidity. The adapting of stock patterns to special jobs is practiced to such an extent in steam-pump and engine shops that it is almost a trade in itself. This work is done largely through the use of stopping-off pieces, and results in a saving in pattern work as well as in the subsequent cost of storing another pattern. Skeleton core-boxes and patterns are also largely used in this work. Shops handling very light work specialize on the follow-board type of pattern, while many patternmakers work a lifetime without having occasion to build a pattern in that way. The use of gated patterns to secure multiple production of small parts is well known, but a knowledge of the use of match-boards is not so common. Loam molding is extensively used in certain lines of work and not at all in others. Many odd jobs have to be produced quickly, and the means for doing them must be inexpensive. Very often the devices used for this purpose are makeshifts that cannot take the place of a properly made pattern, but answer very well for one or two castings.

The fitting of patterns to molding machines is another form of specialization. Generally speaking, there are two types of molding machines: one is called a stripping-plate and the other a vibrator-plate machine. The stripping-plate machine requires a special metal pattern which is mounted on a bolster plate that draws it through the opening in the stripping plate. This opening is made an exact fit for the pattern so that there will not be any danger of breaking the corners of the mold when the pattern is drawn. The patterns are usually mounted so that the cope and drag are made at the same time. Ordinary wood or metal patterns are used on the vibrator machine; these are mounted on a plate that is rapidly vibrated by means of compressed air while the pattern is being freed by drawing away the flask and the plate. The flasks are filled either by hand or by sand fed from a bin through a chute that gives enough fall to partly ram the flask, and the sand is evenly compressed by means of a squeezing device. Many so-called molding machines are not molding machines at all but simply sand rammers or squeezers.

Stopping-off is the process of reducing the size of a mold made by a pattern that is too long or too wide for the required casting, the pattern in other respects being right. This stopping-off is effected by the use of cores or of stopping-off pieces; the latter are sections of a pattern with one side conforming to the form desired. They are placed in the mold to make it the proper size and to form the part adjacent to the section that is to be filled in or stopped off. The stopping-off piece is located by contact with some other portion of the mold or by a heavily scribed line on the cope face of the pattern that is transferred to the sand face; thin strips fastened to the face or side, or a core-print may be used for this purpose.

Cylindrical bodies are stopped off by the use of a half section of pattern made to fit in the mold as at *A*, Fig. 1. The piece is located by means of lines laid off on the joint indicating the length, or by two strips tacked on the body of the cylinder each side of the parting to indicate the length. If a large cylinder is to be stopped off and the stopping-off piece will not stand upright, a batten will have to be fastened across the end to rest on the mold parting and serve as a support.

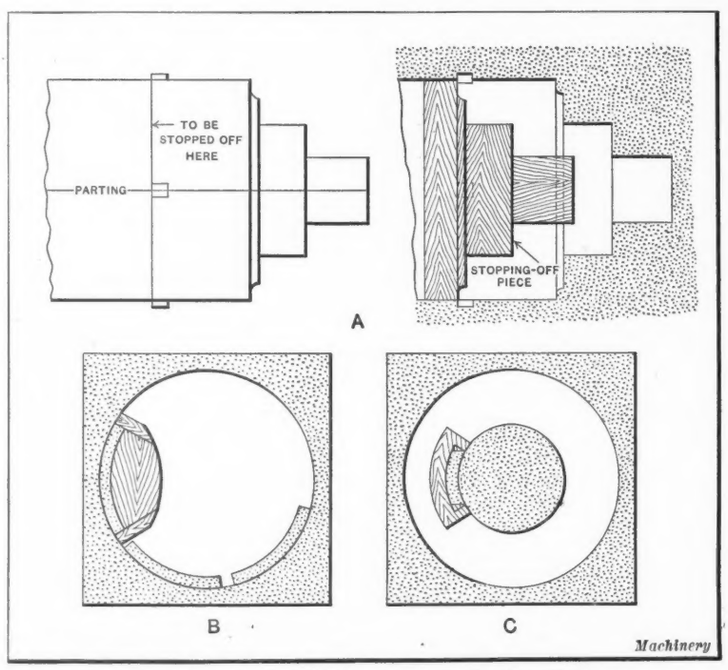


Fig. 1. Examples illustrating Use of Stopping-off Pieces

To stop off a square plate, a narrow piece of pattern is made to lie in the mold to form the new end or side. The stopping-off piece is located by measurements or by blocks fastened to the pattern, corresponding with similar blocks fastened to the stopping-off piece; the blocks on the pattern act as prints and those on the stopping-off piece fit into these prints.

A round plate is stopped off to a smaller diameter by means of a piece made to fill in the mold by ramming up sand segments as illustrated at *B*, Fig. 1. The opposite edge of the piece is sawed to conform to the smaller diameter and used in filling in the spaces between the segments of sand caused by the end pieces on the stopping-off piece. An opening in a ring may be enlarged by the same method, as shown at *C*. The same results could be obtained by the use of segment cores, but the stopping-off method is quicker and gives a better casting.

Square columns are stopped off by fastening blocks or core-prints on the column as at *A*, Fig. 2. Instead of the blocks being fastened, they are sometimes located by strips secured to the pattern. The advantage of this method is that the column can be arranged to stop off to a number of different lengths before being sent into the foundry. These square column patterns are made without end core-prints,

as the core is made of green sand rammed up into the mold. The column or "block," as it is called, is made to the outside dimensions of the column and long enough to form the greatest length required. Two pieces, the width of the sides and of a thickness corresponding to the casting thickness, are made to lie against the sides of the mold after the block is drawn, and the green sand core is rammed between them. These columns have rectangular openings in the back formed by dry sand cores set in the bottom of the mold, and on these are laid flat cake cores on which the green sand core is rammed. These side pieces should be made of quarter-sawed dry pine to prevent warping and twisting, and should be provided with lifting straps to pull them out of the sand.

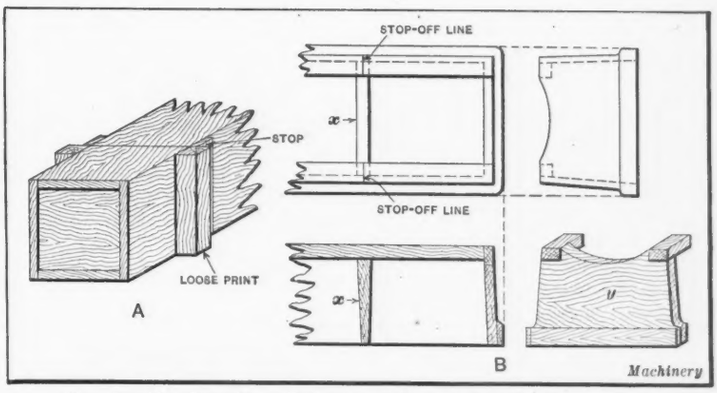


Fig. 2. (A) Stopping off Square Column. (B) Stopping off Bed

Beds are made either to leave their own cores or to have the inside removed by dry sand cores. On bed work, these cores must often be set by measurements, as the print only makes a bed for the core to stand on. The section of a bed shown at *B*, Fig. 2, is made to leave its own core, and is to be stopped off where indicated. With this type of pattern, the inside or core is lifted out to draw the pattern which is molded downward in the floor. A piece *x*, used to stop off the inside or core, is fastened in place with screws, and the stopping-off piece *y* is made in the form of an end with two short sections of flange fastened to it.

Fig. 3 shows a section of a cored bed that is to be stopped off on the depth. To do this, two stopping-off pieces are made to lie in each side of the mold. These are used to strickle a bed upon which are laid the pieces that form the new flanges; after this the space between the flanges is strickled off to form a bed for the core which has also been strickled down to suit. The section through the mold indicates the original line of mold at *e*; the first line strickled to is shown at *b*, and the last line at *c*. The end was stopped off with a new end, as in the first example referred to, except that the pieces of flange were not required. The internal flange on the end was formed by a piece placed in the core-box. The examples shown illustrate clearly the methods used in stopping-off in pattern work, and the adding of further illustrations would not involve any new principles.

Pieces for Enlarging Rings or Plates

Rings and circular plates may be enlarged by supplying the molder with a segment to lay against the outside of the pattern for ramming up the mold to the increased size. Plates may be increased in thickness by supplying the molder with three or four strips representing the added thickness to put under the pattern after he has molded and drawn it. The pattern is replaced in the mold with the strips under it and a new parting made; the required thickness is thus obtained. This method is applied to pulley rims, linings and similar patterns and is called "drawing up."

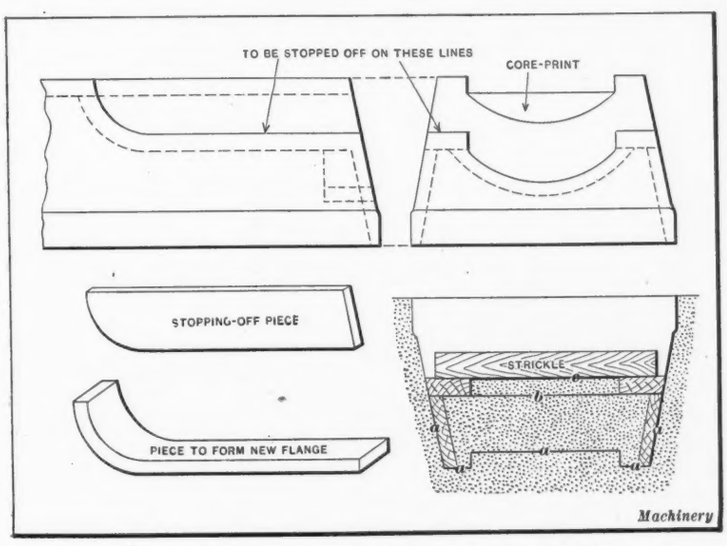


Fig. 3. Bed to be stopped off along the Line indicated

Frames for Enlarging Cores

Portions of cores may be enlarged by means of skeletons or frames placed over the part to be built up, as shown by the core *A*, Fig. 4, part of which is to be increased in diameter. The addition is rammed inside of the frame and strickled off. This could also be done by making a dry sand core to paste to the larger core, but there would probably be trouble in fitting it, as such a core is likely to warp in the drying.

Molds Made with Cores

Molds are frequently made in whole or in part by the use of cores. Hinge lugs and the trunnions on the ends of boxes, are formed in this way; the core is rammed up with the pattern or located by means of prints. An example of a simple mold made with cores is shown at *B*, Fig. 4. All the cores but the central one were made in the box *C*, the end cores being formed by fillers that fitted into each end of the box. Flanges that lie deep down in a mold are always hard to pick in when made loose, and these are best made by the use of a core as at *A*, Fig. 5. The core is made to slip over the projecting piece of pattern and is rammed up with it.

Part Patterns for Plates and Pans

Another subject that must receive consideration is that of part patterns as applied to patterns for plates and pans. Patterns for large plates and pans, instead of being made solid, are framed with the center part open and the thickness strickled out as at *D*, Fig. 4, which shows a section of a mold with the pattern in place. This is done to avoid turning the mold over when it is made in a flask and to facilitate "bedding in" when it is molded in the foundry floor, as it is impossible for the molder to ram the under side of a piece of great area. Portions of beds and baseplates are often framed to mold in this way, and the bottom thickness is strickled in boxes and pots where the pattern is coped off without turning the mold over.

Patterns Made on Follow-boards

Patterns are made on follow-boards when they are very fragile, or they are fitted to follow-boards after they are made, to withstand the foundry ramming. A great many stove and furnace patterns are made on follow-boards, and these are often masters for casting metal patterns. The follow-board is usually made first to conform to the inside or cope side of the pattern as at *B*, Fig. 5, which shows the follow-board on which the light hopper

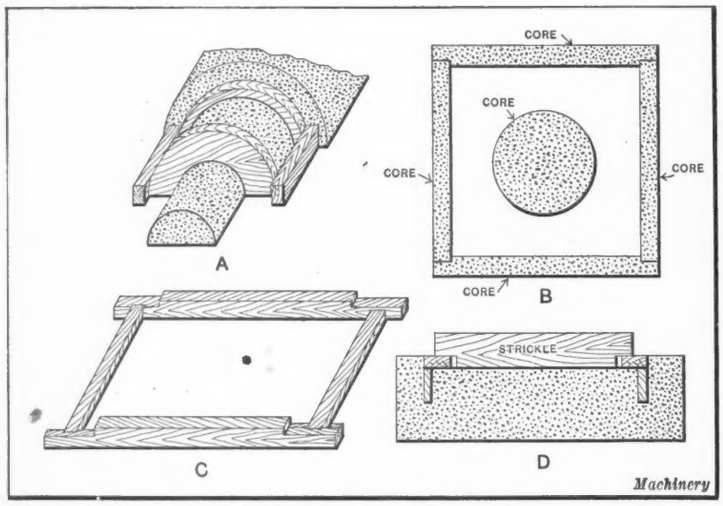


Fig. 4. Examples of Core and Strickle Work

pattern *C* is to be built. The round corners of hard wood are fitted first and they are made to extend beyond the corner radius each way, so that a rabbet, as at *D*, may be cut to receive the rabbeted ends of the sides. The different pieces forming the hopper are glued together and fastened to the follow-board by thin narrow pieces of wood nailed from the outside. A layer of newspaper should be placed between the pattern and the follow-board to prevent any glue that may run through from sticking. The follow-board should be sandpapered and varnished, and instead of newspaper being used, it is sometimes coated with paraffin; but newspaper is preferable for a fair-sized job, as it provides allowance for the varnish and shrinkage.

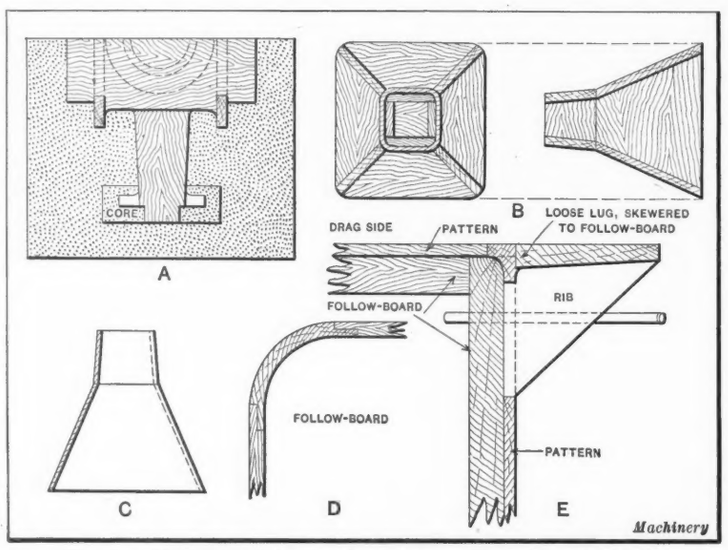


Fig. 5. (A) Core used for forming Flange. (B, C, D, and E) Follow-board Work

Projecting pieces on the outside of a follow-board pattern may be fastened to the follow-board in some cases, so as to add to the strength of the pattern. The rectangular tank pattern partly shown in section at *E*, Fig. 5, had projecting lugs that were always breaking, so the pattern was cut away and the lugs fastened to the follow-board with skewers. The purpose of the follow-board, in some cases, is not only to support the pattern, but also to make the molder's parting. Follow-boards for making partings are very often made in the foundry of plaster-of-paris or litharge. Another variation of the follow-board idea is used in making patterns of boxes that are open top and bottom and have openings through the sides; these openings are made to leave their own cores, the sides being skewered to the follow-board which is lifted out after the outside is rammed and the cope lifted.

Plaster Core-boxes

Master patterns of plaster for casting core-boxes in which small cores are made in multiple are easily constructed by first making duplicates of the cores in wood and fastening them to a board, as shown in Fig. 6. These core duplicates are given several coats of varnish. A frame is afterward fitted around them and filled with plaster; a strickle is used to form the back, the frame acting as a guide for it. Before pouring the plaster, the form should be well greased with vaseline or lard to keep it from sticking; the frame, however, is not greased as it is part of the pattern. To mix the plaster, a sufficient quantity of water is placed in a can, and the plaster added until the mixture is of the consistency of thick cream. If the box is of some peculiar shape that is going to be difficult to duplicate in wood, one pattern could be made and used to form a plaster mold for casting duplicates in plaster.

Plaster core-boxes for odd-shaped pieces can be made by first forming a plaster mold of the piece. A layer of modeling clay equal to the required thickness of the casting is then placed in the plaster mold. This clay can be rolled to an even thickness by using a biscuit roller and two strips of the thickness required. The clay is fitted over the inside of both halves of the mold, and two half-section plaster castings of the core are made and used for forming the core-box. The same plan can be followed in making duplicate plaster-of-paris patterns by first making a mold in plaster from the original and casting as many patterns as are desired. In fitting wooden frames around pieces to be molded in plaster, some means should be taken to keep the plaster from coming loose from the frame; this may be done by boring holes part way through the sides from the inside or by bradding strips to them or even driving a few nails and permitting the heads to protrude.

Skeleton Pattern Work

Skeleton patterns are either frames used for forming the outside of the mold (with dry sand cores to form the interior) or complete framework models designed to form both the exterior and the interior of the casting. In making patterns of this type having a top and a bottom flange, it is usual to notch the ribs into the inside of the bottom flange and into the outside of the top, and fasten them with screws as shown at *C*, Fig. 8. Unless the flanges are round, it is better to make them with splined joints so that they can be band-sawed both inside and out.

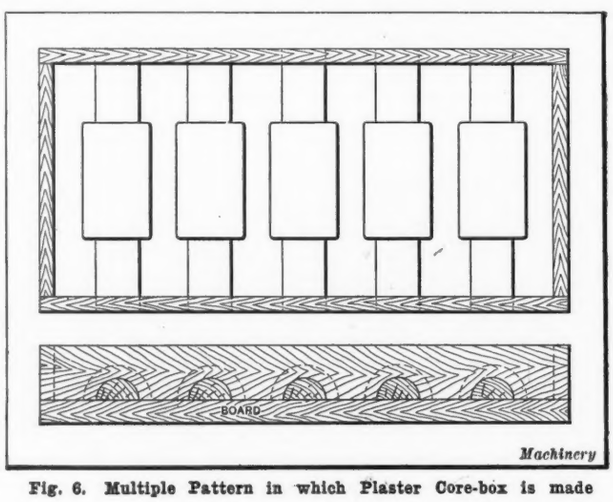


Fig. 6. Multiple Pattern in which Plaster Core-box is made

The crooked pipe *A*, Fig. 7, is a good example of the first type of skeleton pattern mentioned, and it is applicable to elbows, bends, and different forms of pipe work. It is made by doweling two pieces of one-inch stock together and laying out and sawing it to the proper outline. The edges should be rounded to conform to the circle, and the flanges and core-prints fitted. The pieces for forming the prints and body are half round less the thickness of the foundation pieces; they should be made of one-inch stock and, on the bends, the center line of each piece should be radial with the center of the bend radius. One strickle, or "strike," as it is sometimes called (see view *B*), completes the pattern. This strickle is the same diameter as the body of the pattern and is used to strike off or smooth up the clay or loam that is used to fill the spaces between the ribs. This forms a complete pattern which is molded in the usual way.

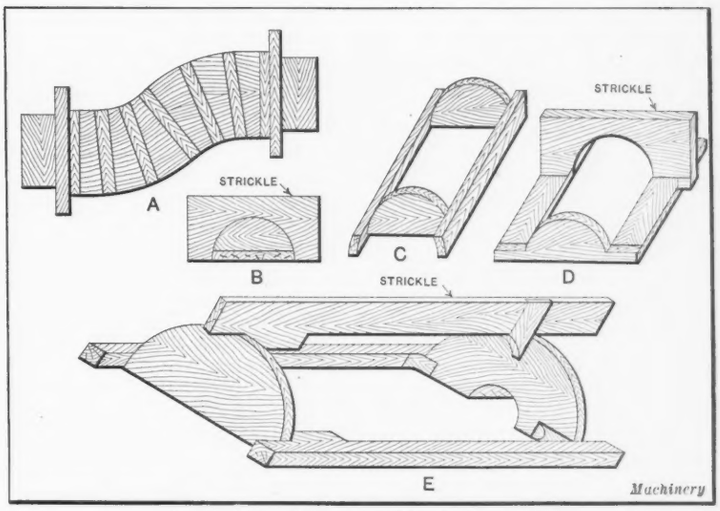


Fig. 7. Examples of Skeleton Pattern Work

Skeleton Core-boxes

Skeleton core-boxes are frames used to confine the core sand which is formed by means of strickles guided in their course by heads fastened to the frame, over which they are worked back and forth; the strickles may also be drawn lengthwise of the frame with the side for a guide. The strickle for the skeleton box *C*, Fig. 7, is a straightedge which slides over the heads. This box is made with the two side pieces screwed to the heads so that it may be changed to different lengths by unfastening one head and moving it to a new position. The core is formed in the box *D* by drawing the strickle lengthwise; this view also illustrates another form of construction in which the heads are prolonged at each side and are screwed to the side pieces. This does not lend itself very well to alterations, but provides a broad space for the strickle to slide on.

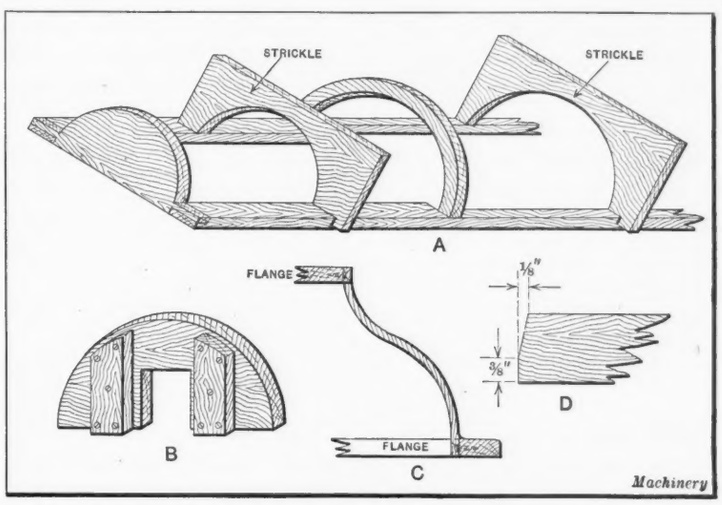


Fig. 8. Details of Skeleton Core-box and Pattern Work

The same types of boxes may be used for forming two or more diameters as illustrated at *E*, which shows a box that is strickled smaller at one end and has the strickle arranged to form a round corner at the other end where the small part of the core is formed by a half-round box made on the head. When more than one diameter is to be formed by drawing the strickle along the frame, it will be necessary to fasten a half ring at the junction of the different diameters as shown at *A*, Fig. 8. It will be noted in this illustration that the side pieces are fastened to the heads by means of a half-lapped joint. This type of box is best when the core is long. In making skeleton boxes, the heads and sides should be stout enough to withstand the ramming as well as rough handling. In some shops it is the practice to use core arbors that run through the end of the box; this necessitates cutting an opening through the head which should be reinforced with battens as at *B*.

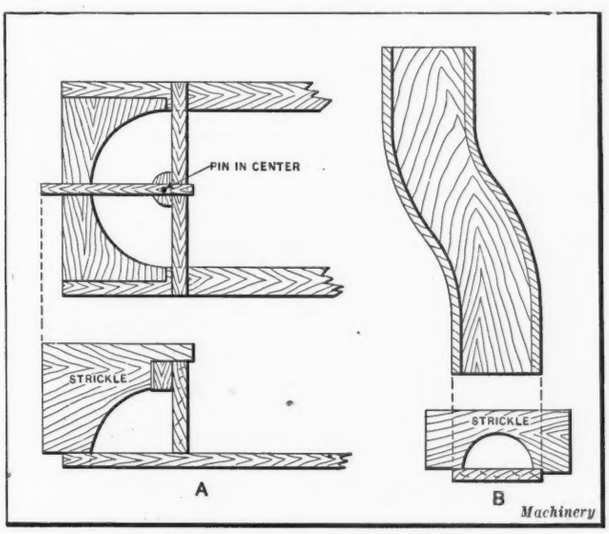


Fig. 9. Examples of the Use of the Strickle

The use of skeletons is not confined to the forming of cores with straight or curved parallel sides, as a large variety of outlines may be secured by using frames and strickles of the proper outline. Hemispherical ends may be formed on the ends of straight cores by arranging a sweep to revolve on a central pin as at *A*, Fig. 9. In making skeletons for pipe bends, it must be borne in mind that the core must reverse or be right and left; therefore, the frame forming the outline must be made complete with the edges square. It is a good plan to make the frame with corner lap joints and fasten the heads with dowels and screws so that they may be changed from side to side. Straight skeleton boxes over 16 inches in diameter should have a third frame piece connecting the heads at the top in the center to add stiffness.

Core-plates

Core-plates are plates of wood or iron that are made to conform to the outline of the pattern, and the core is formed on them by a strickle that is guided by the edge of the plate in the same manner as when using a skeleton core-box. In

making cores in the box, however, the core is made on a metal plate and the box is lifted away from it; but when the core is swept up on a plate, it goes into the oven without being removed, so that if the plate is of wood it must be substantial enough to withstand the heat. In making a wooden core-plate for the pipe illustrated at *A*, Fig. 7, the pattern is laid on a piece of suitable board and the outline marked; the prints are made the same size as the body of the pipe. The core-plate and strickle for this pipe are shown at *B*, Fig. 9. If the core is to be right and left, no battens can be placed on the plate, as a core must be made on each side of it. It is the practice in some shops to place half-round heads on the ends of core-plates and these are often necessary, particularly in forming branches at right or other angles to the body of the core. In making patterns for iron plates, a double amount of shrinkage must be allowed. These are usually made of 1/2-inch stock and are battened to hold them straight. All the strickles should be beveled on the working edge as at *D*, Fig. 8.

Match-plate Work

An important subject is that of match-plates. To expedite the molding of small patterns, they are often mounted on plates with the cope side of the pattern on one side of the plate and the drag on the other. The slide-valve casting *A*, Fig. 10, illustrates this method. The pattern for this casting is mounted on one side of the board and the steam recess is carved out of the other side as at *B*; it will be noted that the flask pins are fitted through the match-board so that it will always be in the same place in relation to the flask. A number of patterns are usually mounted on the plate, and this work must be accurately done to secure good results. The gate and runners are usually made on the cope so that the molder does not have to touch the mold when it is finished. An example of turned work mounted on a match-plate is shown at *C*. The core-print, in this case, is elongated to fit a hole bored in the plate, and the cope part of the pattern slips over it, thus insuring that the cope and drag will come in line.

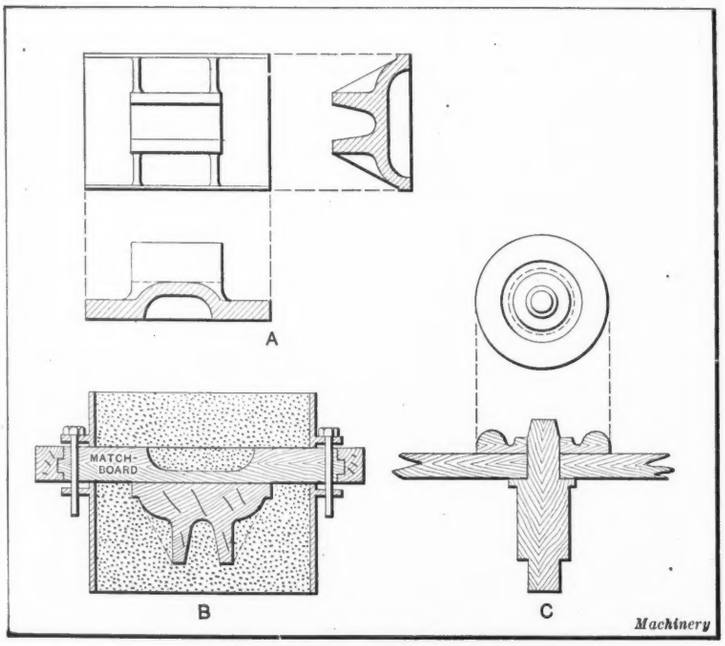


Fig. 10. Examples of Match-plate Work

Chills

Chills are pieces of metal placed in a mold to harden certain surfaces by having the molten metal come into contact with the chill. Chills may be used as part of the mold or in the same capacity as a core. A popular example of chilled work is a car-wheel rim in which that part of the mold that forms the rim is of metal. The patternmaker's job, in this case, is to fit the pattern to the chill as they are rammed up together; if a round hole is to be chilled, core-prints are fitted to the pattern and the chill is made with considerable taper so that it may be driven out. It is sometimes desirable to make sections of pipe to bolt together without finishing the flanges; and to do this, metal ends are used in the mold, not to chill the casting but to form a finished flange. In this case, the flanges are made long to form core-prints for the metal ends, the face sides of which are grooved with concentric V-grooves to give the packing a hold. The core is carried on an arbor that fits openings turned in the end pieces which are also drilled with holes through which the bolt hole cores are pushed.

Gated Patterns

Gated patterns are small patterns fastened to the runners and gate pin to form a multiple pattern which can be used to mold a number of pieces at one time. The patternmaker is sometimes required to make wood patterns on a gate, but more often he furnishes but a single pattern from which the molder casts the required number of patterns and then proceeds to mold and cast them on a gate. This gated metal pattern is then sent back to the shop to be filed smooth and have drawn iron holes drilled and tapped in it.

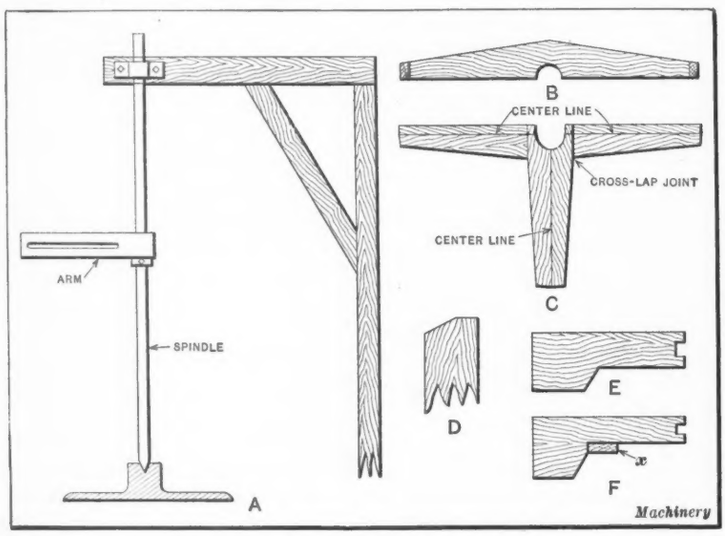


Fig. 11. Equipment Used for Loam-molding

Splitting Hubs and Pulley Rims

Pulley and flywheel rims and hubs, as well as bosses on levers, are frequently cored part way through so that they may be broken after machining. This is done so that they can be placed on a shaft after it is installed, or to provide for a compression joint to avoid using keys or set-screws. If the core required is thick in proportion to its length and width, a dry sand core may be used for this purpose, but often the piece to be removed is very thin, and instead of a sand core a piece of iron plate is used. A core-print should be provided and the splitting plate coated with something to prevent sticking. It is often coated with glue over which core sand is sprinkled so as to cover it, and it is then coated with some form of facing.

Pattern Work for Loam-molding

In making molds in loam, the molder may use a pattern or any of the devices that are applied in

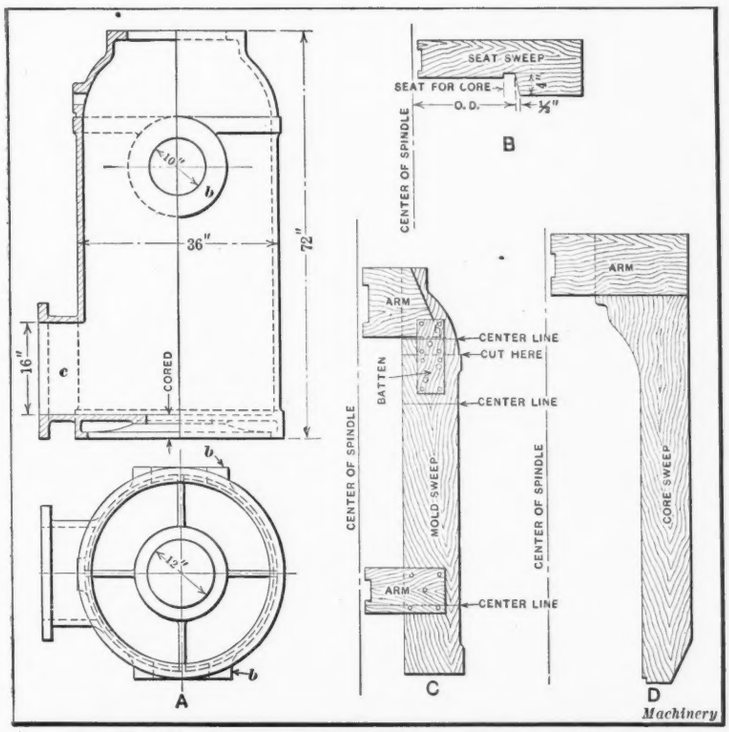


Fig. 12. (A) Example of Loam-molding. (B, C, and D) Use of Sweeps

forming molds in green or dry sand; but loam work lends itself more readily to cylindrical bodies that may be formed by the use of sweeps revolved around a central spindle. The cylinder may have branches, bosses, or other projections, and patterns are made for these as though they were to be fitted to a cylindrical body that had been built up and turned. The foundry rigging used for sweep work is shown at *A*, Fig. 11. It consists of a vertical spindle which is supported by a plate at the bottom and a pillow-block at the top. The spindle may be a piece of shafting but more often it is a tube closed at one end, and it is usual to have two or three sizes on hand. To hold the sweeps, an arm is fitted to the spindle; this arm has a slot in it for bolting the sweeps in place and it is kept in its proper position by a collar and set-screw. The side of the arm to which the sweep is bolted is in a vertical plane intersecting the spindle center. Instead of the hole in the arm being made to slip over the spindle, it is more convenient to make it slotted and have it fastened to the spindle with a gib and key, as it is more easily removed.

A loam mold is built on an iron base or foundation plate provided with three or four lugs and sometimes with other projections to carry portions that extend beyond the main body of the mold. A top plate with lugs corresponding to those on the bottom is used to fasten the mold together after it is finished. Loop clamps are slipped over these lugs and fastened by driving wedges through the loop at the top.

The jet condenser body shown at *A*, Fig. 12, is a good example of a loam job, and will give a fair idea of what the patternmaker is required to furnish for this type of work. Patterns were made for the projecting bosses *b* and the flanged nozzle *c*; these were provided with core-prints, and boxes were made in the same manner as if the job were to be molded in green or dry sand. The recess in the bottom was formed also by a core for which a box was made. To draw the flanged nozzle through the side of the mold, a cake covering core was provided to fit over the core-print. A full-size lay-out was made, showing the thickness of metal, finish, centers of hubs and bosses, and the seat parting at the bottom corner of the mold.

In starting a loam job, the first thing to ascertain is the size of the spindle to be used and then to make, from a piece of 1/2 or 5/8-inch stock, what is known as a "gage-stick" *B*, Fig. 11, on which is indicated the inside and outside diameter of the job. This is used to set the sweeps to, and the semicircular notch in the center should fit the spindle.

Seat Sweep

The seat sweep *B*, Fig. 12, was made first to sweep the parting at the bottom of the mold for the condenser shown at *A*. As the bottom recess was to be removed with a core, a projection to sweep a seat for the core was placed on this seat sweep. The taper and depth of seat are usually regulated by some shop standard; in this case, the depth was 4 inches and the taper 1/8 inch per inch.

If the mold were for a cylinder with a flange at the bottom, the seat sweep in this case would have to be cut away beyond the taper to the top of the flange, and a piece *x* fastened to it to form a mold for the flange as at *F*, Fig. 11. This piece is fastened with screws and is removed to sweep the sand pattern which is formed in the mold made with the piece in place; this is done to avoid an under-cutting finger that would have to be placed on the mold sweep to form the flange.

The Body and Core Sweeps

The body or mold sweep *C*, Fig. 12, for the condenser shown at *A*, was made of 1 1/4-inch dressed stock and had two arms that were halved into it to make it flush on the face; the arms are sometimes abutted against the sweep and fastened with battens, which is a good plan if they are to be taken apart in the molding. The inner ends of the arms were notched to fit over the hubs on the arm clamps to abut them against the spindle. On the face of the sweep the centers of the nozzle and bosses were plainly scribed and this sweep was cut where indicated so that it could be removed from the mold, the two pieces being held together by a batten that doweled and screwed into place. The core sweep *D* did not differ essentially from the body sweep except that it had but one arm and was centered to sweep the inside or core.

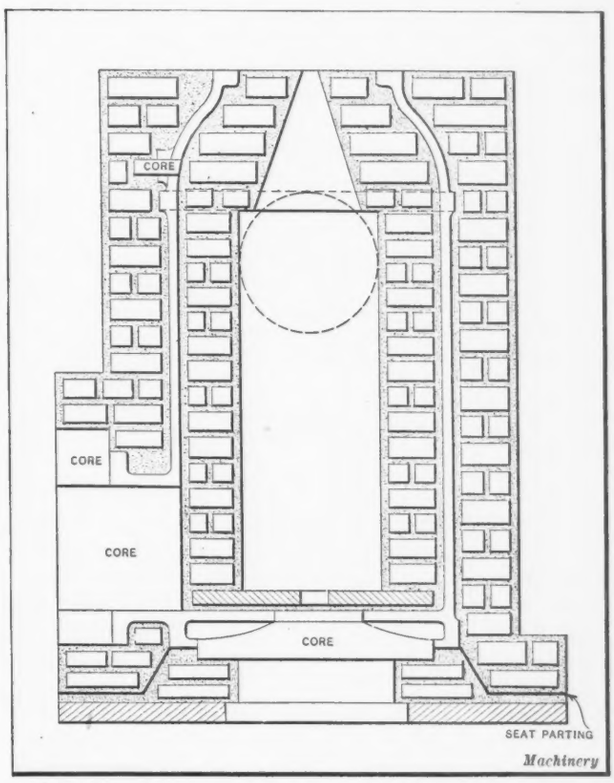


Fig. 13. Sectional View of Mold for Condenser Casting shown at A, Fig. 12

Beveling Sweep Boards

The sweep edges were beveled as at *D*, Fig. 11, so as to force the loam against the brickwork. The molder usually holds the sweep and draws it toward him with his left hand while he applies the loam with his right, the beveled edge of the board being toward him. The proper edge to bevel may be determined in this way.

Centering Gage

The center lines on the sweep (see view *C*, Fig. 12) located the centers for the nozzle and bosses in a vertical direction, and to locate them circumferentially a centering gage *C*, Fig. 11, was made of light stock; this gage fitted around the spindle, and the centers were transferred from it to the mold. When work of this kind is being done the mold is swept first and lifted off the seat to permit sweeping the core. All loose pieces used in loam work should have well defined center lines, and these lines should be carried entirely around the piece. A section of the condenser mold, Fig. 13, shows the different parts formed by the sweeps and the patterns.

Loam Patterns and Cores

Loam patterns are sometimes formed by means of a spindle and sweep or by frames and strickles. The usual procedure when operating with the spindle and sweep is to sweep up the core first and dry it. The outside of the pattern is then swept up by applying sand to the core to form the thickness of metal. This sand pattern is used to mold with, and the sand formerly applied to obtain the thickness is removed so that the core is ready for use. Loam cores are formed by boards pressing the loam against a barrel which is wound with straw rope and revolves in a horizontal position. The patternmaker is concerned only with the boards that must be shaped and beveled on the edges to give form to the core.

The patternmaker does not have to concern himself about partings in loam molds to the same extent that he does when a pattern is made for green or dry sand work. The principles of molding should be observed, but owing to the construction of a loam mold, the molder determines the location of the parting.

Using Old Castings as Patterns

When breakdowns occur there is not always time to make a new pattern to take the place of the broken part, so the old casting must be patched up and used for a pattern. When there are holes in bosses and hubs, these may be plugged, and this will enable the patternmaker to attach thin material by brads to allow for finishing the casting. When there is no chance to fasten the "finish," the molder should be provided with a piece of the proper size and thickness to cover the surface and should add on the required amount. Paper and cardboard are frequently wound around cylinders and fastened with shellac or tied in two or three places with a piece of string. Narrow wooden strips may also be used in this way. Under-cutting bosses can be utilized by fitting pieces under them to form tailprints; a piece is then made to set into the mold while the tail is stopped off.

* * *

Cadmium solders may be used for soldering tin plate, terne-plate, brass and copper, according to an investigation recently made by the Bureau of Standards. Four different compositions of cadmium solders have been tried: (1) Lead, 90 per cent; cadmium, 10 per cent; (2) lead, 80 per cent; cadmium, 10 per cent; tin, 10 per cent; (3) lead, 85 per cent; cadmium, 10 per cent; tin, 5 per cent; (4) lead, 75 per cent; cadmium, 10 per cent; tin, 15 per cent. The manufacture and use of the alloy first mentioned is rather difficult, because it oxidizes easily in the molten condition. The best composition is said to be that containing 80 per cent of lead and 10 per cent each of cadmium and tin.

TEACHING SHOP PRACTICE BY MOTION PICTURES

One of the best motion pictures produced in the shop practice field has recently been shown to mechanical audiences under the auspices of the Cleveland Twist Drill Co., Cleveland, Ohio, which company has staged a four-reel motion picture on the use and abuse of twist drills. This picture illustrates in a striking manner what can be accomplished in the machine shop field along the lines of teaching shop practice. Briefly described, the picture is a text-book on the construction and the proper use of twist drills, the latter lesson being best brought home to the audience by pointing out the various abuses to which twist drills are frequently subjected in the shop, and by emphasizing the methods that should be employed in order to obtain the best results and the highest efficiency from twist drills.

In the early part of the picture, the correct definitions of the various terms used in connection with twist drills are clearly given and instructively illustrated. Such terms as "body clearance," "lip clearance," "web," "web increase," etc., are explained in a manner that will create a lasting impression, and later the results obtained in drilling by the use of drills having correct and incorrect clearance, point angle, length of lips etc., are shown. The various abuses to which the workman frequently subjects twist drills are then taken up, and every point is made unusually clear by showing the whole procedure step by step. The staging of the picture is cleverly done, giving a humorous touch here and there, so as to prevent the instructive part from becoming too dry or the interest to lag. Well selected captions, giving further emphasis to the points brought out by the picture are interspersed at frequent intervals, and aid materially in creating that lasting impression and in producing that educational value that the picture is intended to possess.

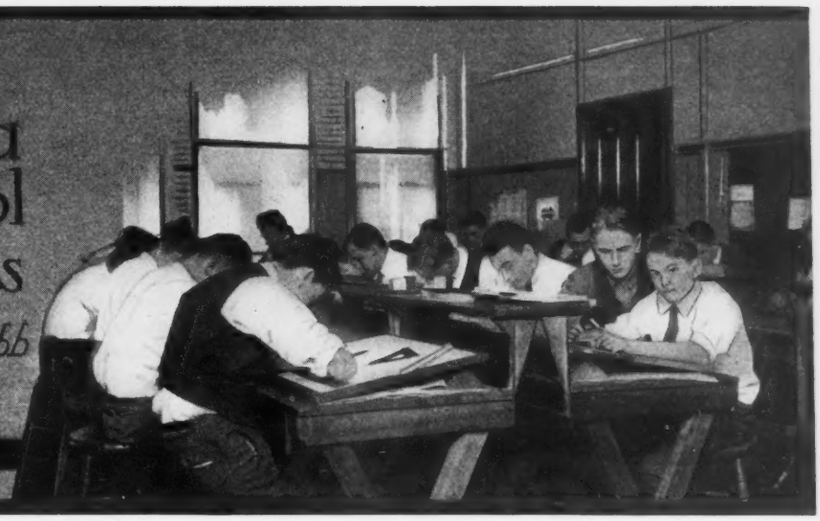
An unusual and commendable feature of the film is that it does not give the impression of having been produced for advertising effect, but purely for general educational purposes along correct shop practice lines. Except for the name of the company that produced the film, and an outside view of the Cleveland Twist Drill Co.'s plant there is no reference to that company or its products. It is a distinct step toward the ideal shop educational picture, and the producers are entitled to credit for their work.

The picture, however, opens up a trend of thought as to the possibilities of the motion picture in the industrial field for training and educational purposes. The eye catches an idea more easily and quickly than the ear and except for the great cost of producing a film, such as the one described, there could be no better means for effectively instructing workmen or students in regard to mechanical principles. The engineering and trade schools of the country should have—as part of their standard equipment—a series of motion picture films of mechanical practice, carefully produced by men who really understand all the underlying mechanical principles, and not by a motion picture expert only. If this were done, much time could be saved in the instruction of young men, and they would get a clearer idea of the work in the industries.

The industries themselves also will find a great value in the use of the motion picture to instruct operators properly in the use of machines and tools. It is to be hoped that the users of twist drills, for example, will take full advantage of the film mentioned which will be sent to manufacturers and dealers—free of charge—by the Cleveland Twist Drill Co., in order that it may be exhibited to those interested. By the use of a portable picture machine, the film can be shown anywhere—in an office, a show room, or in the shop. When films of this kind become commonly used to instruct workmen in the proper use of machines and tools, it is reasonable to expect that the cost of broken and damaged machines or tools will materially decrease.

Organizing a Trade School Along Business Lines

by Dean B. Cobb



IN order to obtain the advantage of cooperative effort among boys, which is difficult to do unless the interest of the boys is definitely enlisted, a plan has been adopted by the drafting department of the Boardman Trade School at New Haven, Conn., whereby the whole drafting class is arranged as a commercial organization. The greatest problem of an instructor is that of securing and holding the boys' attention. Many methods have been worked out which have proved successful in some instances, but the same methods do not always succeed in different schools, either on account of different departmental organizations or because of the differences in the teaching force.

The method to be described has been in successful operation for the past year. The scheme of the system is outlined in Fig. 1 which shows an organization diagram of the drafting-room of the Boardman Trade School, which is arranged on the same plan as employed in industrial organizations. The chief draftsman, assistant chief draftsman, and the squad chiefs are students. The organization is headed by the instructor who supervises in general everything going on in the department. Next in line is the chief draftsman who reports to the instructor and who has an assistant. Next to the chief draftsman in authority are the squad chiefs, who are in charge of two or three boys. In addition there is what is known as an assistant squad chief.

The students are divided into two classes or divisions, A and B. The chief draftsman must be a class A boy; so must also the assistant chief draftsman and the squad chiefs. The only executive position that is open to a class B boy is that of assistant squad chief.

The Duties of the Officials

The chief draftsman is responsible for the condition and discipline of the drafting-room when the instructor is busy, and he assumes complete charge of the room during the absence of the instructor. He checks drawings and tracings before they are handed to the instructor. From this it is evident that the chief draftsman acts as an authority in the room and that his decisions can be overruled by no one except the instructor. An early development of executive ability is thus obtained, enabling the boy to promote those activities which are necessary in an executive position. The duties of the assistant chief draftsman are to assist the chief draftsman in all his work and help him when necessary. One of the special duties of the assistant chief is that of checking all time sheets and seeing that the time is properly entered. He also checks all the work that is done personally by the other squad chiefs. Another one of his duties is that of taking complete charge of all magazines that come into the room. Articles in these magazines are marked for different boys to read.

The duties of a squad chief consist of maintaining discipline in his squad, and of checking all tracings and drawings made by his squad boys before being passed to the chief draftsman. He is to assist his squad boys in every way possible, and in case a very important question arises he submits it to the chief draftsman for settlement. If the chief is in doubt, the question is then submitted to the instructor for a final decision. By this method the squad chiefs begin to develop responsibility. The supervisional duties of the assistant squad chief are but few. One of them is that of maintaining order in the room during the absence of all the officials above him, which in a sense, develops responsibility in the younger boys. Other duties of the assistant squad chief are to assume the authority of the squad chief during his absence, and to assist the instructor during any tests that are being taken by the B class. Thus it will be seen that each of the officials has his distinct duties to perform and they are such as to develop responsibility and executive ability in the boys.

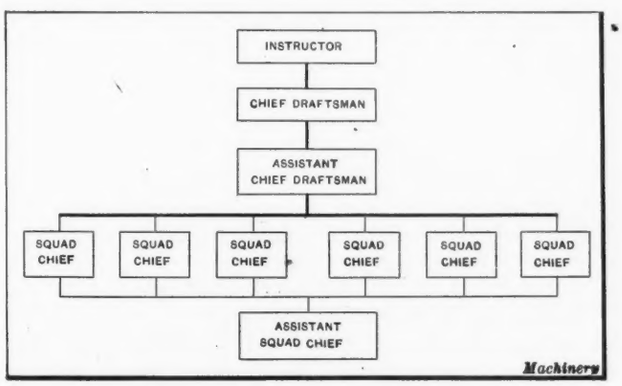


Fig. 1. Organization Diagram of the Drafting-room Class at the Boardman Trade School

TIME CARD

Name_____

Job_____

Date Started_____ Date Finished_____

Drawing		Tracing	
Time Allowed	Actual Time	Time Allowed	Actual Time

Credits_____ Demerits_____ Checked by_____

Percentage_____ Approved by_____

Fig. 2. Time Card on which is marked the Credits, Demerits and Percentage of the Student

TAKEN BY	DAILY REPORT					DATE	
	JOB					EST. TIME	
NAME	SYMBOL	PLATE NO.	DESCRIPTION	HRS.	%DONE	MO.	DAY

Fig. 3. Report Sheet on which Daily Progress of Each Student is Recorded

The Checking System

In order to ascertain thoroughly just how much each boy knows, a checking system has been installed, based upon the following points. The colored pencil system is used to enable the instructor to give proper credit to the boys. This system may be explained by taking as an example a drawing made by a squad boy and following this drawing from the time it leaves the squad boy uncorrected, until it has been corrected and returned to him. It goes first to his squad chief, who may find, say, ten mistakes, which he corrects with a blue pencil. The drawing then passes to the chief draftsman who may find three more mistakes, which are marked with a green pencil. It is next passed to the instructor who, in the final checking, may discover two errors, which he marks in red. He also makes other notations as he sees fit, such as the number of credits or demerits, lines too light, etc., after which he marks the necessary credits and demerits on the time card, shown in Fig. 2. The drawing is then passed back to the chief draftsman who notes the corrections, and he, in turn, passes it to the squad chief who finally passes it to the squad boy. By this means each boy who has checked this drawing becomes acquainted with all the mistakes that have been made. All drawings before being handed in to the instructor must be checked by two members of the drawing-room organization, that is, one member outside the chief draftsman must check the drawing. This practice causes the work to be properly checked before being handed in to the instructor.

System of Recording Time, and the Other Marks

When a drawing is handed out to any member of the drawing-room, a time card such as shown in Fig. 2 is given to the boy; this contains spaces for the following information: name, name of job, date started, date finished, time allowed, and actual time spent in making the drawing. At the bottom of the time card are spaces for entering the number of credits and demerits and the percentage attained, as well as for entering the name or initials of the person by whom the drawing was checked and approved. When a squad chief gives a boy a job, he allows him so many hours to do the drawing. When the job is finished, the actual number of hours is properly entered on this card, which accompanies the drawing all the way through to the instructor,

	DATE and JOBS									
Knodel	DR. JIG 6/7/19 6/11/19									
Phelps	DR. GRIN. TABLE 6/7/19 6/9/19									
Tate	DR. / PLATE 25 6/7/19 6/7/19									

Machinery

Fig. 4. Ruled Form on which the Progress of Each Student is shown by a Record of All Drawings made

who marks thereon the necessary credits or demerits and the percentage. This enables the instructor to check up all work thoroughly without spending unnecessary time looking up the different jobs. From this time card, the number of credits or demerits are recorded in a book. This book contains the date of the entry and also shows whether the drawing was made by the student or simply traced or checked by him. If it was drawn or traced, it shows the hours allowed and the actual number of hours on the job. The number of credits or demerits allowed and the percentage received are also entered in the book. In case the job consists merely of checking, the name of the person who made the drawing and of the checker are shown in separate columns.

Another time card, shown in Fig. 3, is called the daily record and is filled out each night by the clerk of the room. He records this information on a recording sheet, Fig. 4, which shows at a glance the work each boy is doing. On this sheet the name of the job is entered, the date it is

TABLE GIVING VALUES USED IN MARKING DRAWING FOR CREDITS AND DEMERITS

Assembly	Perfect	5	Credits
"	1-3 Mistakes	3	"
"	4-6 "	1	"
"	7-10 "	1	Demerit
"	11-15 "	3	"
"	16-20 "	5	"
"	21 and above "	15	"
"	Poor printing	1	"
"	Dirty paper	2	"

DETAILS

Number of Parts 1-20 Inclusive			Above 20 Parts		
Perfect	5	Credits	Perfect	10	Credits
1-3 Mistakes	3	"	1-8 Mistakes	5	"
4-8 "	1	"	9-15 "	3	"
9-15 "	3	Demerits	16-20 "	3	Demerits
16-20 "	5	"	21-25 "	5	"
21 and above "	15	"	Over 25 "	10	"
Poor printing.	1	"	Poor printing.	1	"
Dirty paper...	2	"	Dirty paper...	2	"

TRACING

Perfect	3	Credits	
1-3 Mistakes	1	"	
4-5 "	2	Demerits	
6-10 "	5	"	
Over 10 "	10	"	
Finding Mistakes after drawing is checked	1-3	5	Credits
	4 and above	10	"

started, the time that it is expected to be finished and the date it is actually finished. If the job is finished on the date expected, it is crossed out; if not, the actual date is filled in. The accompanying table gives the values used in marking the drawing for credits and demerits. Illustrating this by using the previously mentioned example, we find the following marks: The squad chief found ten mistakes, the chief draftsman found three and the instructor found two, making a total of fifteen for the squad boy. According to the schedule, if the number of detail parts is from one to twenty, inclusive, he is given three demerits. The squad chief in checking overlooked only five mistakes, thus entitling him to one credit; the chief draftsman who overlooked only two mistakes gets three credits. By posting the number of credits and demerits each month and the percentage, the comparison will show which student is doing the best work in the room.

General Remarks

In order that the boys may feel that they have something to say in conducting the organization, an official meeting is held every Saturday morning, and is attended by the chief draftsman, assistant chief draftsman, squad chiefs, and assistant squad chiefs. The instructor is also present, acting as supervisor. The chief draftsman presides, and all

subjects that pertain to the organization are brought up at this time and thoroughly discussed. During one of these meetings it was proposed that a "Suggestion Box" be put into use. The proposition was adopted and has proved to be of much value. All suggestions that are received in this box are brought into the squad chief meeting and acted upon. For a good suggestion, credit marks are allowed by the squad chiefs, the number depending upon the suggestion, subject to the approval of the instructor. The minutes of these meetings are posted on a bulletin board for the benefit of the whole room. This bulletin enables the entire room to understand how its management is being conducted. For the benefit of the boy's welfare, a squad chief social is held in one of the boys' homes each month. This event tends to promote a better understanding between the instructor and the boys, as well as among the boys themselves.

In conclusion, a few advantages resulting from the employment of this scheme may be mentioned, among which are the development of responsibility in a boy; the acquirement of an understanding of business organizations; and the faculty of thinking independently, which is developed by the checking system, as it brings up many questions that would not otherwise have been thought of. The system also permits the instructor to place his boys advantageously as the occasion arises. The incentive to become a squad chief is also an advantage, in that it encourages better work and greater endeavor.

* * *

USE OF CARDBOARD TEMPLETS FOR TESTING SPECIAL GEARS

By W. MANGOLD

When designing special gears, it is considered advisable to test the tooth outlines by some means before cutting the gears. This may be accomplished by making templets of the teeth from heavy smooth cardboard which can be obtained in large sheets. A portion of each gear is accurately drawn on the cardboard with a hard lead pencil, after which it is cut out, the center of the gear being on the same sheet. In the case of a gear having large teeth, a full size lay-out may suffice, but in most cases the teeth should be drawn to as large a scale as convenient. When the sheet is too small to include the center of the gear, another strip of cardboard may be pasted to it so as to permit the center to be on the same sheet. Probably the quickest and best method of cutting out the tooth outlines of gears is to take a beam compass, having needle points in each leg, and go carefully over the outlines of the teeth with a needle point. By doing this a number of times, a smooth accurate cut is made through the cardboard without injury to the hardened needle point. A bow divider may be used to cut the lines of small arcs or fillets. After the templets have been made, any error in the design of the mating gears may be detected by locating the centers of the templets a distance apart equal to the center distance of the gears; then holding the templets in place by pins through the centers; and finally turning the templets to and fro with the teeth in mesh.

* * *

ANNUAL MEETING OF S. A. E.

The annual meeting of the Society of Automotive Engineers will be held in New York City, January 6 to 8, 1920, at the Engineering Societies' Building, 29 W. 39th St., New York City. During the same week, the passenger automobile show will be held. The meeting of the Automotive Engineers will include four professional sessions with two evenings of entertainment. On January 6, there will be a Standards Committee meeting, and in the morning and afternoon of January 7 and 8, there will be professional sessions.

RECOMMENDED PRACTICE FOR BEVEL GEARING

At its meeting in Boston, in October, the American Gear Manufacturers' Association adopted as recommended practice the following rules with regard to the design of bevel gearing. The accompanying table, adapted from MACHINERY'S ENCYCLOPEDIA, was accepted as giving the proper size of shafts for bevel gears according to horsepower. The sizes given should be regarded as the smallest limits, and the designers of gear drives should use larger sizes when convenient in order to be on the safe side. The importance of making the overhang of bevel gears on the bearings as short as possible was emphasized.

Length of Face

The maximum length of face of bevel gears should not be over one-third of the cone distance for gears up to 3 inches pitch diameter and not over one-quarter of the cone distance for gears from 3 to 20 inches pitch diameter, assuming that the pitch in every case will be in proper

HORSEPOWER TRANSMITTED BY SHAFTING MADE OF MEDIUM STEEL

Diam. of Shaft	Number of Revolutions per Minute				
	100	150	200	250	300
1½	5	7	10	12	14
1⅝	6	9	12	15	18
1¾	8	11	15	18	22
1⅞	9	14	19	23	28
2	11	17	23	28	34
2⅛	14	21	27	34	42
2¼	16	24	33	41	48
2⅜	19	29	38	48	58
2½	22	33	45	55	66
2¾	30	44	59	74	89
3	39	58	77	96	116
3¼	49	74	98	123	148
3½	61	93	123	153	184
3¾	75	113	151	188	226
4	91	137	183	228	274

proportion to the size of the gears. A safe rule is to make the face from one and one-half to two and one-half times the circular pitch.

Length of Bearing

The minimum length of bearing along the face is to be at least one-half the length of the face when the gears are held in correct alignment. Gear users should test the strength of the gear housings as follows: Block the driven gear shaft and then apply a lever to the shaft of the driving gear and measure the displacement of both gears when a dead load is applied through the lever. This measurement can be made by inserting feelers or shims on the driving side of both ends of the teeth before and after the load is applied.

Shape of Teeth for Bevel Gears

Bevel gears with generated involute teeth of standard addendum, having a pressure angle of 14½ degrees may be used according to the following rule:

Ratio	Number of Teeth
1 to 1	14 and over
1½ to 1	18 and over
2 to 1	19 and over
3 to 1 and over	21 and over

The recommended practice rules as given are confined mainly to gears up to 20 inches pitch diameter as distinguished from larger gears. They also apply to average machine design as distinguished from gears for automobiles.

The adoption of the recommended practice for bevel gearing by the Gear Manufacturers' Association is one of the steps along the path of the standardization work that the society has made one of its chief aims.

Machine Tool Trade in Sweden

By G. A. LINDSTEDT, Director of A. B. Galco, Ltd., Stockholm, Sweden

THE industrial conditions in Sweden at the present time are far from satisfactory. Sweden is dependent upon export business, and the most important export markets in the past were in the East—toward Russia. This market has been cut off by conditions too well known to be mentioned. When the Russian situation made business there impossible, the Swedish industries began to develop export trade to Norway, Denmark, Holland, and Spain, but the demand in these countries was not sufficient to keep the industries fully employed. As a result, all the Swedish industries have been working on stock for a long time, and the financial conditions, as a whole, are greatly strained. Most of the Swedish industries are now working with only from 50 to 60 per cent of the force employed during the war.

With most of their working capital tied up in stock, the industries are unable to expand in a normal manner, and the general opinion which seems to prevail in the United States, that Swedish industries are still flush with the great war profits made, is erroneous. A great many of the concerns in Sweden had to rely upon outside sources for their raw materials, and these were contracted for at prices much higher than those prevailing at the present time. In this way, much money is tied up in raw materials that can now be bought for one third the price originally paid.

Another reason for the strained financial conditions is that, during the war, there was a great deal of buying done by Swedish concerns of raw materials and foodstuffs from all countries of the world. These goods generally had to be paid for in cash before leaving the foreign port, and were then held up by the British Government as a war measure, as Great Britain feared that the goods were intended for Germany. Much material that had been paid for was thus held in England until it could be proved that goods were intended for home consumption in Sweden, or for export to neutral countries. These processes of adjustment are still going on, and have tied up an enormous amount of capital in goods that have either never been received or were received after the prices had been so materially reduced that a loss was inevitable.

The Germans owe large sums of money to the various manufacturing industries in Sweden, but these sums will not be paid for a long time to come, because the allied governments, as the result of the peace treaty, naturally require that Germany should first pay the indemnity to the belligerents before making any adjustments with neutral countries.

These conditions indicate that, at the present time, any trade with Sweden must be based upon liberal credits. The lack of cash wherewith to make immediate payments does not mean that the well-known importing concerns in Sweden are unsound financially. On the contrary, it may be said that credit may be given without risk to any of these houses. A three months' credit, however, to a foreign concern, is of no particular value, because it often takes more than three months for machines to reach their destination. A foreign dealer, if he is to benefit by the cooperation on the part of the manufacturer of machine tools in the United States, must be given long credits, because he, in turn, must give credit to the manufacturer who buys the machines from him. The prevailing conditions necessitate longer credits than do the conditions in normal times.

Practically no American machine tools were imported into Sweden during the war. The factories were much enlarged, however, and were filled with machine tools made in Sweden, which, in most cases, cannot be compared with the American tools, either in regard to accuracy or to productive capacity. Hence, there is a certain demand for high-class machine tools in Sweden, but as the factories have no orders, and from 50 to 60 per cent of their machine tools stand idle, it is evident that at present they will not buy more machinery, nor will they be able to do so for some time to come. Furthermore, the effect of the exchange rates—the low rate of German exchange and the high rate of dollar exchange—makes itself definitely felt. Several Swedish manufacturers are making preparations for further enlargement of their works by taking advantage of the present low rate of German exchange. The machine tools thus bought are not needed at the present time, but are bought merely because of their cheap price when paid for with Swedish crowns exchanged into German marks. Many Swedish firms already have German marks in Germany and are simply seizing the opportunity of disposing of them by taking products in exchange, as they cannot get money out of Germany in any other way without a serious loss, due to the low value of the German mark.

German competition is so keen at the present time that it is impossible to sell American machine tools with the exception of certain highly specialized types to which the Germans offer no competition. It is only a question of time, however, before even these machines will be copied by the Germans, making competition still more difficult. Six months ago, it was not believed that the German competition would be serious, and it would not be, were it not for the present low value of the German mark. The Germans are able to demand twice as much for the machines for export as compared with those that they sell at home, and yet, when the machines are paid for by foreign money, the price is low. The following examples will give an idea of present prices of German machine tools sold in Sweden.

Vertical milling machine from a high-grade maker: Net weight, 9000 pounds; single pulley, all-gear drive; all power feed; longitudinal feed, 50 inches; horizontal feed, 18 inches; vertical feed, 14 inches; equipped with rotary table. Price, Marks 29,960—equivalent to approximately $1200 at present exchange rates.

Horizontal boring, drilling and milling machine: 5 1/4-inch spindle diameter; 70 inches longitudinal feed of table; 55 inches horizontal feed of the table; longitudinal travel of the spindle, 47 1/2 inches; all modern construction and a close copy of a well-known American make; net weight, 45,000 pounds. Price, Marks 85,100, or approximately $3500.

Vertical boring mill: Single pulley, all-gear drive; 54 inches maximum turning diameter; similar to one of the best known American machines; net weight, 22,000 pounds. Price, Marks 62,700, or approximately $2500.

Universal grinding machine: 8-inch swing; 20-inch grinding length; similar to one of the best known American machines; net weight, 2300 pounds. Price, Marks 11,300, or approximately $450.

Planer: 7 by 7 by 12 feet; modern construction, American type; net weight, 38,000 pounds. Price, Marks 74,650, or approximately $3000.

The Germans have so thoroughly canvassed the Swedish market that they are capturing every order. It is difficult to suggest anything that can be done to change the situation at present, but the foregoing remarks merely are a record of the facts for the information of American manufacturers.

Labor Conditions in Sweden

As regards labor conditions, there is, in Sweden, as everywhere else, a considerable amount of labor unrest. Strikes are prevalent everywhere, but although there is a radical element of Bolshevik tendencies, the conservative workmen constitute the majority, and it is only a question of time when proper adjustments will be made that will prove satisfactory both to employer and to employe. One of the most important leaders of the Swedish Socialist party has issued an appeal to the Swedish workmen, stating that further demands on manufacturers for higher wages must cease, because the manufacturers cannot, under existing conditions, increase wages. Greater production only will bring higher wages, and the workmen are requested to lend their energies in this direction. Wages in Sweden are very high as compared with pre-war conditions. A good toolmaker in Sweden receives from 16 to 20 crowns per day (at present exchanges rates, from $4 to $5 a day), and bricklayers or carpenters get from 35 to 40 crowns a day (at present exchange, from $9 to $10 a day).

Prospective Russian Market

The business with Russia is absolutely unsettled. It does not seem possible that Russia can begin to buy for a couple of years to come, because everything in Russia is completely disorganized. However, even this statement is a mere guess, because nobody knows anything definite about the conditions in Russia. Possibly a stabilized government could place Russia on her feet very rapidly. Sweden has sent cargoes of products to Russian ports in the Black Sea, but this business has been founded on an exchange basis; that is, exchanging the goods on the Swedish ships for hemp, linen, etc., loaded on the ships in the Russian port.

* * *

DRIVER FOR GRINDERS AND LATHES

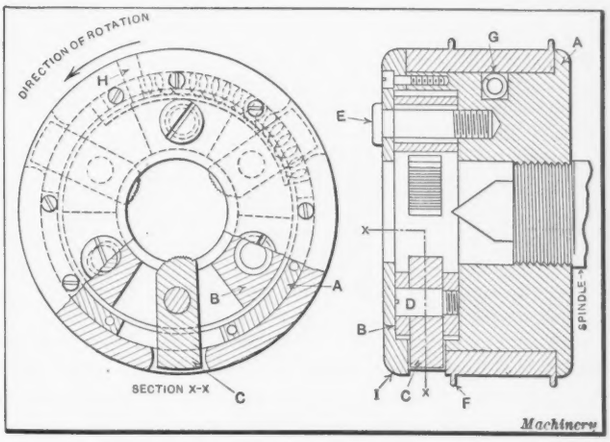
By T. L. STALKER

The driver or chuck which is here illustrated was designed for revolving work held between the centers of a lathe or grinding machine. The special feature of this device is that it permits the insertion and withdrawal of the work while the machine is in operation. The construction of the appliance is clearly shown in the illustration. The steel body *A* is threaded to fit the spindle of the machine, and is counterbored so as to provide space for the floating ring *B*. This ring has three slots in which the hardened steel jaws *C* are held by the pivot pins *D*. The ring is held in the chuck body by means of plate *I*, pins *E* and fillister-head machine screws. The flanged sleeve *F*, which is a running fit on body *A*, has three slots along the edge adjacent to plate *I*, which receive the outer ends of jaws *C*. An expansion spring *G* is contained in a recess in body *A*, one end of which bears against pin *H*, which is a drive fit in sleeve *F*. When the device is assembled on the machine, a plain leather brake, that is connected to a foot-pedal, is arranged to bear between the flanges on sleeve *F*.

When in operation, the jaws are opened for the insertion of the work by exerting pressure on sleeve *F* by means of the brake. This retards the motion of the sleeve and causes pin *H* to compress spring *G*. As the outer ends of jaws *C* are held in slots in sleeve *F*, this action causes the jaws to pivot on pins *D*, thus opening the jaws sufficiently to permit the work to be inserted. When the brake pressure is released, spring *G*, acting upon pin *H*, forces the sleeve forward, thus pushing against the outer ends of the jaws in a counter-clockwise direction, causing the jaws to pivot on pins *D* and bear against the work. The grip of the jaws on the work is automatically tightened when the cutting tool is brought in contact with the work, by reason of the toothed construction of the end of the jaws.

It will be noted that two of the holes in ring *B* through which pins *E* pass are circular, while the third one is elongated, the distance across the width of this hole being less than the diameter of the circular holes. When the work is in the chuck, the device is driven by the pin that passes through the elongated hole, there being sufficient clearance around the other pins so that they do not touch the ring. This clearance allows the ring to adjust itself when the work is not entirely concentric with the spindle centers. Holes are provided around one edge of the flanged sleeve to permit the use of a spanner wrench in case the work should become wedged so hard between the jaws that the chuck could not be opened by means of the brake.

The correct strength of spring *G* must be determined for different sizes of chucks, because if the spring is too strong it will be impossible to open the chuck jaws while the machine is in motion, and if the spring is too weak, the jaws will not be closed properly. The curvature of the gripping end of the jaws depends upon the size of the chuck. In cases where the chuck is very sensitive, it is frequently necessary to equip the brake with a device that will lessen the friction on sleeve *F* when pressure is released on the brake.



Chuck for driving Work held between the Centers of a Lathe or Grinding Machine

* * *

NEW BEARING METAL

A development in bearing metal which is the outgrowth of the scarcity of tin during the war was of great value to the Government during the period of hostilities. It is an electrically hardened lead with a very small percentage of other ingredients added which had never before been used in bearing metals. The Bureau of Standards made a series of tests on this new bearing metal and issued a report showing that the tensile strength of the metal is 13,000 pounds, the elastic limit 11,525 pounds and that it is capable of enduring a running test at a pressure of 1000 pounds per square inch at a speed of 400 revolutions per minute. The final temperature was only 150 degrees F. The report stated that this metal possesses all the requisites of a good bearing metal, that is, hardness, compressive strength, low friction, and heat resistance, as well as low cost.

* * *

REMOVING BUSHING FROM BLIND HOLE

A novel method of removing a bushing from a blind hole is mentioned by one of our contemporaries. There was not space enough at the bottom of the hole to obtain a grip with a hook of sufficient strength to pull out the bushing. After several other methods had been tried without success, a rod was made that fitted quite accurately into the bushing. The hole was then filled with heavy oil, the rod inserted, and driven in with a hammer against the pressure of the oil, the fluid pressure of which transferred the force of the hammer blows to the inner end of the bushing, forcing it out with very little difficulty.

Machining Impeller Pump Cylinders

Methods Employed for Facing Flanges, Drilling and Tapping Flange Holes, and Boring Cylinder

At the plant of S. F. Bowser & Co., Inc., in Fort Wayne, Ind., the factory is required to machine impeller pump cylinders of the form shown in Fig. 1. There are a number of interesting operations connected with the manufacture of these parts, but in this article a description will merely be presented of the methods that are employed for facing the flanges, drilling and tapping the flange holes, and boring the cylinder. The cylinder boring operation is the most interesting of the three, because of the peculiar shape of the cylinder. All of these operations, except tapping the flange holes, are performed on a battery of high-duty drilling machines built by Baker Bros., of Toledo, Ohio, which are set up in line and equipped in such a way that work may be passed along from machine to machine, for the performance of a sequence of operations which would ordinarily be regarded as typical turret lathe jobs. The flange holes are tapped by a machine built by the Garvin Machine Co., New York. This tapping machine is equipped with individual motor drive and mounted on a skid, so that it may be pulled into place on an elevating truck which deposits the machine beside the battery of drilling machines, for the period during which the tapping operations have to be performed.

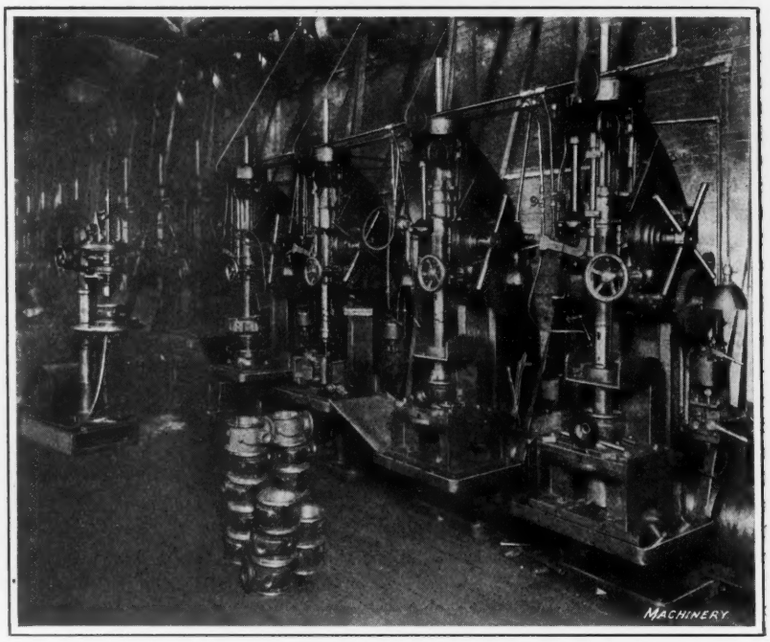


Fig. 2. Battery of High-duty Drilling Machines for drilling and boring Cylinder Castings, and Portable Tapping Machine for tapping Holes in Flanges

It will be apparent from the form of the pump cylinders, as shown in Fig. 1, that after the flanges have been faced on the left-hand drilling machine shown in Fig. 2, there are holes to be drilled in the flanges at both ends of the cylinder. In order to facilitate the performance of these drilling operations as far as possible, the jig used for this purpose was so designed that after the work has been set up, all of the holes may be drilled without the necessity of resetting. This result is accomplished by having bushings arranged in both the top and bottom plates of the jig, with provision for turning the entire jig over after one set of holes has been drilled, in order to locate the work for drilling holes in the opposite flange.

Fig. 3 shows the jig set up for drilling, and from Fig. 4 a better idea will be obtained of the construction of this tool. The holes to be drilled are located on the circumference of a circle, and at both the top and bottom of the jig there are three feet *A*, which are made in the form of segments of circles. The entire jig rests on a baseplate that is secured to the drilling machine table, and on this plate there is a circular track which engages the feet *A*. With such an arrangement, it is merely necessary to drill one hole, and after the machine spindle has been withdrawn, to push the jig around by hand until the next bushing has been brought into position under the drill. This procedure is repeated until all of the holes have been drilled. Then the jig is turned over so that the three feet *A*, at its opposite side, rest on the circular track, after which the same sequence of movements is repeated to drill the holes in the opposite flange.

Standing on the machine table in Fig. 3, there will be seen two quick-change collet chucks. There are 1/2-inch tapped holes and No. 0 holes to be drilled, and to save time in changing tools, these quick-change collets are utilized. The method of setting up the pump cylinder casting in this jig is quite simple. To put a casting into the jig, the top plate must first be removed. It will be seen that there are three pins *B* which enter holes in the top jig plate *C* to assure accurate location of this plate, after which nut *D* is tightened in order to clamp the plate down onto the work held in the jig. The location of the work in the jig is obtained from the flat faces of flanges that surround the intake and discharge openings. After the drilling operations have been performed in this jig, the work is transferred to the portable tapping machine for tapping the ½-inch holes, which operation does not involve any unusual procedure requiring description.

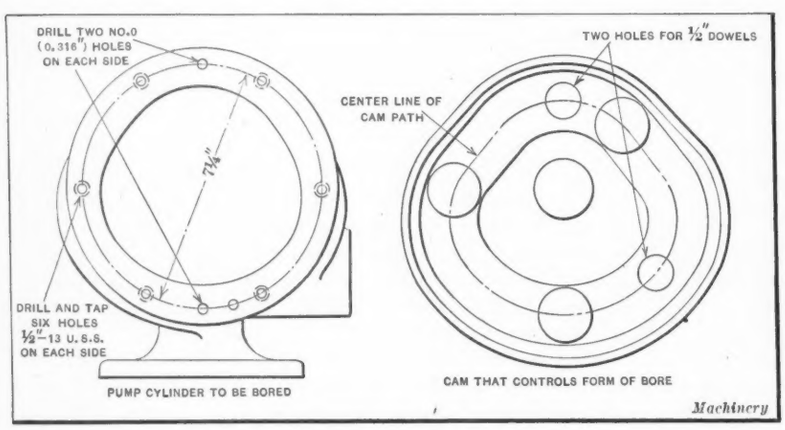

DRILL TWO NO.0 (0.316") HOLES ON EACH SIDE
TWO HOLES FOR ½" DOWELS
CENTER LINE OF CAM PATH
7¼"
DRILL AND TAP SIX HOLES ½"-13 U.S.S. ON EACH SIDE
PUMP CYLINDER TO BE BORED
CAM THAT CONTROLS FORM OF BORE
Machinery

Fig. 1. Pump Cylinder to be bored, and Cam on Boring Tool that controls Form of Bore

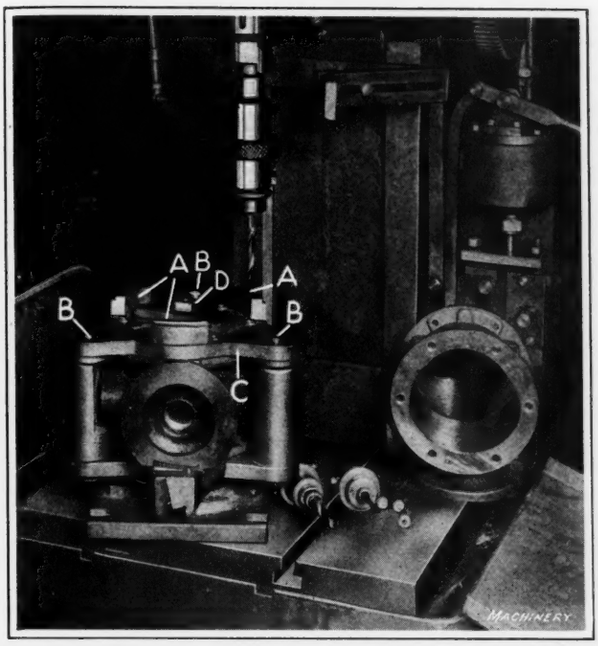


Fig. 3. Close View of Jig used for drilling All Flange Holes in Cylinder Casting at a Single Setting of the Work

Machining the Eccentric Cylinder Bore

It will be apparent from Fig. 1 that the bore of the pump cylinder is not of the usual circular form, as a result of which the problem of devising a method of machining was more difficult to solve than if it had merely been necessary to provide for machining a cylindrical bore. Fig. 5 shows a close view of the tool provided on a Baker high-duty drilling machine for the performance of this cylinder boring operation. Two machines are equipped for this job. Before starting to describe the mechanism of this boring tool, it will doubtless be helpful to make a general statement as to the method by which the work is done. The boring tool is mounted on a cross-slide that is free to move transversely, so that the path followed by the tool point may be governed by a cam of the same contour and size as the cylinder bore. As the tool rotates, its radius from the center of rotation is constantly changing, and is controlled by the cam, so that the tool point bores the cylinder to the desired shape.

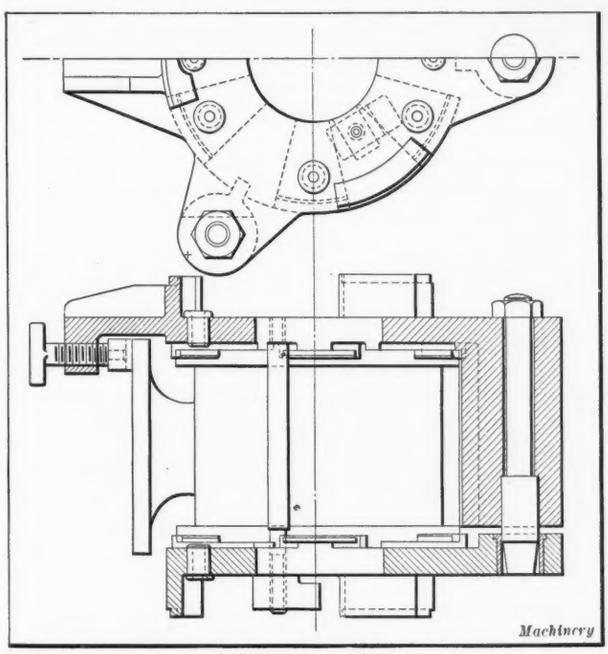


Fig. 4. Sectional and Plan View of Drilling Jig shown in Fig. 3

Having made a general statement as to the method of procedure in handling this boring operation, we are ready to enter into a detailed description. This tool is designed in such a way that the lower portion may be dropped out of the position which it occupies inside the pump cylinder, in order to allow the work to be lifted off the machine. A fresh casting is then put into position, and the lower part *A* of the boring tool is raised into place inside the work, in order that pilot *B* may enter a bushed hole in the upper tool member *C* to assure accurate alignment. The rear end of the cross-slide on which the boring tool is mounted carries a cam roller *D* that enters the cam groove *E*. Very little thought will make it apparent that aside from its vertical movement, the lower tool member *A* is held stationary, while the upper tool member *C* is secured to the drilling machine spindle so that it rotates. This rotary movement results in carrying cam roller *D* around in the stationary cam groove *E*, this groove being carefully machined to conform in both shape and size to the contour of the pump cylinder. As the cam roller is secured to the rear end of the slide on which the boring tool is carried, it will be apparent that the radius of the boring tool point from the

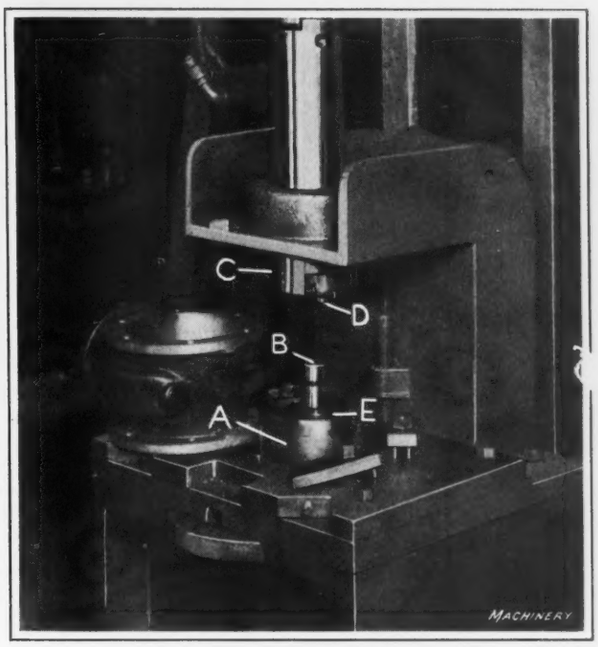


Fig. 5. Close View of Tool used for boring the Cylinder. The Cam that controls Form of Bore is shown in Fig. 1

center of rotation is constantly changing, in order to make this tool bore the cylinder to the required form. In addition to its rotary movement, the upper tool member *C* is fed downward by the drilling machine spindle, so that the boring tool is traversed from end to end of the cylinder to complete the boring operation.

The eccentric cylinder bore is finished in two cuts without taking the piece out of the fixture. This result is accomplished by changing the tool steel bits carried by the upper tool member *C*, which was so constructed that it only requires about fifteen seconds to make the change. By having two machines employed on the boring operation, which are semi-automatic in their operation, one man and a helper are able to operate four machines employed for facing, drilling, and boring these parts, and also to tap the holes on the Garvin tapping machine. E. K. H.

* * *

In a paper published in the Bulletin of the American Institute of Mining and Metallurgical Engineers, it is stated that in making acceptance tests of moderately hard steels, better results are obtained if the test pieces are allowed a day's rest between the time they are machined and the time they are tested.

Component Drawings for Interchangeable Manufacture

Second of Two Articles on Methods of Dimensioning Drawings and Indicating Tolerances

By EARLE BUCKINGHAM, Engineer, Pratt & Whitney Co., Hartford, Conn.

THE previous article on this subject, published in the November number of MACHINERY, stated the general laws of dimensioning, and gave examples showing their correct and incorrect application. The dimensioning of composite surfaces and compound tolerances were also discussed.

Dimensioning Force Fits

The dimensioning of a taper key and its seat offers a very instructive example. In this case, we have a drive fit so that instead of clearances we must concern ourselves with the establishment of the proper interferences. Fig. 19 illustrates such a key and its seat. The functional conditions to be maintained demand that we have always an interference of at least 0.002 inch and never have a greater interference than 0.008 inch. The illustration shows clearance at those points at which no bearing is required. Often, however, we find drawings for such functional conditions specifying fits on all surfaces. Such conditions add nothing to the strength or effectiveness of the construction but entail unnecessary refinement in the manufacture of the detailed parts with a correspondingly increased cost. Fig. 20 illustrates the details of such a condition dimensioned in a very common manner. This method of dimensioning is wrong. The key in this sketch violates the first, second, third, and fifth laws of dimensioning; the slide violates the second, third and fifth laws; while the dimensioning on the seat violates the first, second, third, and fifth laws. With the dimensions given as they are, it is impossible to specify tolerances that will insure the required functional conditions unless we reduce each tolerance to a fraction of a thousandth. The dimensions and the tolerances as they stand permit, in some cases, the key to be tight in the slide and loose in the seat of the slide. In other cases, the reverse is true. Parts made to the basic dimensions will have a fit on all surfaces.

Fig. 21 shows these parts dimensioned in accordance with the laws of dimensioning. It will be noted that with parts made to the basic dimensions, the key will be driven home to its head, with an interference on the bearing surfaces specified of 0.002 inch. The direction of the tolerances on every dimension affecting these bearing surfaces is such that this interference is increased as the sizes of the parts vary from the basic dimensions. Under maximum metal conditions, the bottom of the key will be flush with the bottom of the slide with an interference of 0.008 inch on the functional surfaces. It should be noted that by giving the dimensions in this manner, the required conditions are always maintained, while the manufacturing tolerances are greatly increased. Both slots are made with parallel sides to facilitate machining. Fig. 21 offers a good example of the application of the fifth law of dimensioning. This illustration should be carefully studied and compared with Fig. 20. Note, in particular, the ease of checking the functional conditions in Fig. 21 as contrasted with the difficulty and confusion which arises if we attempt to determine the possible combinations permitted in Fig. 20. Note also how the relative extent of the tolerances specified in Fig. 21 calls attention to the essential functional surfaces. These same relative conditions exist between any drawings that are dimensioned without careful study as compared with those which are rationally and logically dimensioned. No attempt has been made in this example to express any dimensions other than those which affect the taper key and its seat. The example given in Fig. 14 on page 262 of the November number shows the proper dimensioning of the dovetail slide.

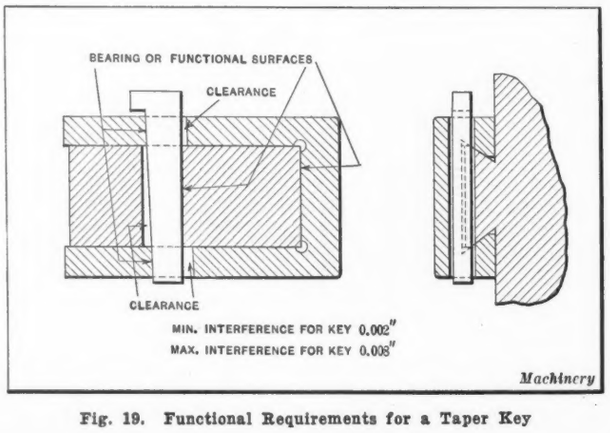


Fig. 19. Functional Requirements for a Taper Key

Dimensioning of Profile Surfaces

The dimensioning of contours with tolerances introduces still another problem. To give tolerances on the various dimensions which establish the basic contour inevitably introduces compound tolerances. On the other hand, it is often impossible to resolve such composite surfaces into elementary ones for the purposes of dimensioning and checking, because their dimensions and relative locations are inseparable. Fig. 22 illustrates one satisfactory solution of this problem. The basic dimensions of the profile are given without tolerances. A dotted line is drawn parallel to the basic contour which indicates the direction of the tolerance. A dimension is given between the full (or basic) outline and this dotted line which specifies the extent of the tolerances. This method of dimensioning gives definite information which can be used directly in the manufacturing departments.

Dimensioning of Holes

The dimensioning of the location of holes with tolerances is a most difficult problem. These dimensions are usually given to the centers of the holes and define neither male nor female surfaces. They must be used in conjunction with the diameters of the holes, thus establishing a composite surface condition. The introduction of tolerances on these dimensions of location immediately will produce compound tolerances.

We might dimension them as shown in Fig. 23 by giving one dimension to the inside edges of the holes (which is a male dimension), another to the outside edges of the holes (a female dimension), and eliminate the dimension for diameter. This would

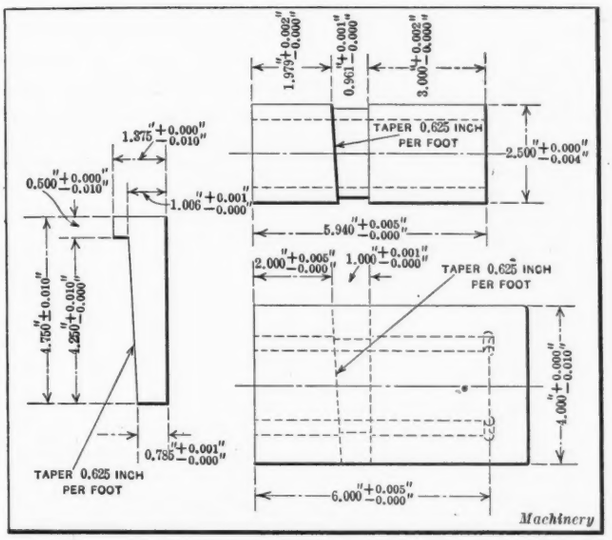


Fig. 20. Incorrect Dimensioning and Design of Details shown in Fig. 19

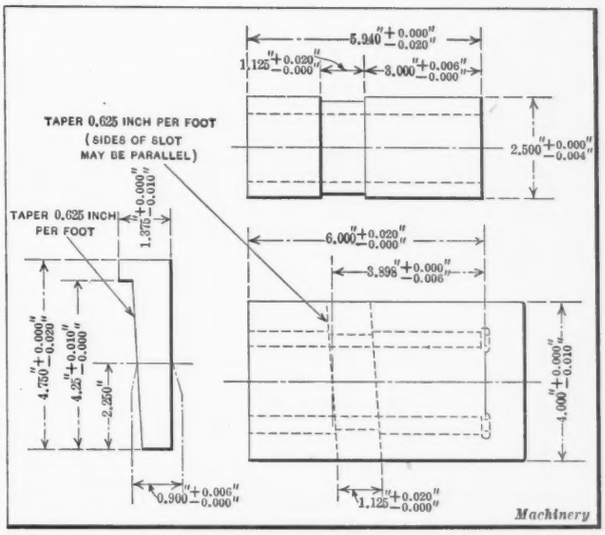


Fig. 21. Correct Dimensioning and Design of Details shown in Fig. 19

give us a better opportunity of applying the five laws of dimensioning in a similar manner to that employed for elementary surfaces. However, this would prove unsatisfactory in practice because it does not give directly the information which is of most value in the shop—namely, the diameters of the holes and the center distances.

No rules can safely be given for dimensioning the location of holes in which the permissible variations are distinctly expressed, unless the required functional conditions are duly considered. The following examples give possible solutions of a few of these problems. If these solutions are accepted, the corresponding interpretations, expressed in terms of inspection gage requirements, must also be accepted. For the first example, we will take the base for a bracket and its pad on a frame illustrated in Fig. 24. We will assume that the position of this bracket on the frame is important and must be held as closely as manufacturing conditions will permit. We will assume also that the jigs from which these holes are drilled locate the parts on the finished surfaces from which the dimensions are given.

Causes of Variation in Manufacture

Variations of locations in manufacture develop from three main causes: First, from a fixed error in the jig; second, from a difference in size between the drill and its bushing in the jig; and third, from improper location of the parts in the jigs. Variations occurring because of the first cause will affect the locations of the holes both in relation to each other and to their locating surfaces. Variations because of the second cause will have similar effects to those developing from the first cause. Variations because of the third cause will affect only the location of all holes as a unit from the locating surfaces. Thus, with these problems, there are always composite variations to contend with. The surfaces involved are always composite, and a condition of compound tolerances is always present.

If precision, rather than absolute accuracy, is the main consideration, and if these locations in the two jigs check with each other, the variations due to the first cause may be disregarded, provided that the gages which check these locations are made to agree with the jigs.

The variations due to the second cause may be reduced to comparatively small amounts by closely maintaining the relative diameters of the drills and their bushings. This naturally involves a somewhat increased maintenance cost of the equipment. The extent of the variations due to the third cause depends upon the design of the jigs and the care exercised by the operator. In general, the third cause is responsible for the largest amount of variation.

The locations in Fig. 24 are given without tolerances, yet the drawing should not be interpreted to mean that no variations are permissible. The minimum clearance between the studs and the holes is 0.004 inch. This clearance is provided to allow for the variations in their locations. Therefore, this clearance should be considered in testing the locations of these holes.

The inspection gage for testing these locations would be a functional gage which invades this minimum clearance. There are two conditions to be considered here which affect the amount of the minimum clearance that may be used on the gage. If the studs used are loose, individual pieces which pass through both parts and are bolted or riveted at assembly, the functional gage may utilize the entire minimum clearance. On the other hand, if the studs are first driven or riveted into one member, these functional gages could invade the minimum clearance not over fifty per cent. In either case, it is possible to make a single gage which will check both parts.

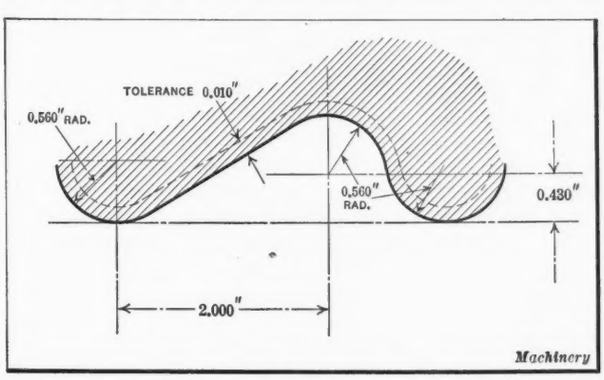


Fig. 22. Sketch showing Satisfactory Method of specifying Tolerance on Contours

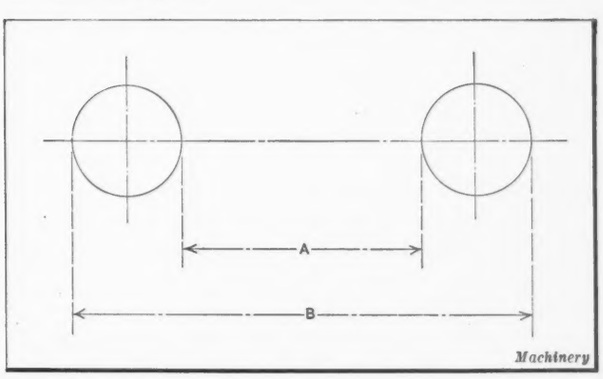


Fig. 23. Diagram illustrating Conditions met with in measuring Holes

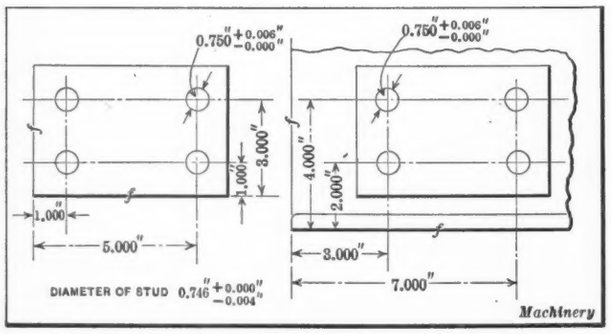


Fig. 24. Methods of Dimensioning the Location of Holes

We will first consider the functional gage to check the first of the above conditions. This gage would consist of a plate with four pins, as shown in Fig. 25. It checks both the locations of the four holes relative to each other and the location of the group from the edges of the part. The locations of the pins are identical with the corresponding basic dimensions given on the component drawings. The diameter of the pins is 0.746 inch (basic diameter of hole minus minimum clearance). The gage must always enter all four holes on the part. When the gage is held against the upper edge of the holes, the lower edge of the gage must not project below the lower edge of the component. When held against the lower edge of the holes, the lower edge of the gage must not be above the lower edge of the part. This checks the vertical position of the holes. The horizontal locations are checked in a similar manner. The diameters of the holes are checked as elementary surfaces with limit plug gages made to the specified limits.

Thus, although both the drawings and the gages are made to flat dimensions, a tolerance on all positions of the holes has been established. If their relative locations were perfect, under maximum metal conditions of the various holes, a variation of 0.002 inch either way would be permitted on their location from the edges of the parts. If the various holes were made to the maximum limits, this variation could be 0.005 inch either way. On the other hand, if the position of these holes as a unit were perfect in regard to the edges of the components, a variation of 0.004 inch would be permitted on their relative locations under maximum metal conditions, with a correspondingly increasing tolerance as the parts approach minimum metal conditions. This would amount to 0.010 inch at the extreme minimum metal condition. Inasmuch as variations will develop in both types of locations, all that is not consumed by one is available for the other.

We will now consider the functional gage to check the condition where the studs are rigidly fastened to one of the parts. A gage for this purpose would be similar to the one shown in Fig. 25 except that it would contain four holes instead of four pins. Such a gage is shown in Fig. 26. Four plugs would be used with this gage for testing the locations of the holes in one piece, while the holes in the gage would go over the studs fastened to the companion part. The diameter of the holes in this gage and also of the plugs is 0.748 inch (basic diameter of hole minus one-half minimum clearance or basic diameter of stud plus one-half minimum clearance). This gage would be used in exactly the same manner as the first. The permissible variations under maximum metal conditions of the holes and studs would be but one-half that permitted in the first case. As these holes and studs approach minimum metal conditions, the permissible variations in location would increase in the same manner and extent as in the first case.

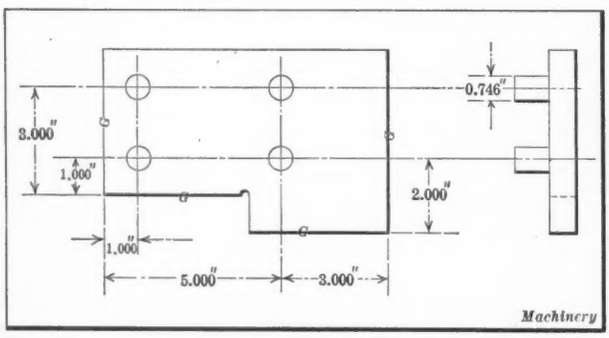


Fig. 25. Functional Gage for Part shown in Fig. 24

In Fig. 24, the locating dimensions are given from common locating surfaces in each direction. They could be given as shown in Fig. 27. As long as no tolerances are expressed, the method most convenient for the shop is best.

Expressed Tolerances on Location of Holes

If expressed tolerances for locations of holes are insisted upon, it is impossible to avoid compound tolerances. Then an arbitrary method of interpretations must be promulgated to prevent continual argument and misunderstanding. Fig. 28 illustrates two methods of indicating such tolerances. We assume that the functional conditions are identical with those previously discussed in the first case of Fig. 24. This is one example where the mean size is the proper basic dimension, and tolerances apply equally plus and minus.

In order to establish the sizes of inspection gages we must consider the tolerances, instead of minimum clearances. Referring to Fig. 23, an inspection gage to check the relative locations of the holes must be made to the maximum dimension A and the minimum dimension B. In the horizontal direction, the maximum limit of A is equal to the maximum center distance (4.004 inches) minus the minimum diameter of the hole (0.750 inch) which amounts to 3.254 inches. The minimum limit of B in the same direction is equal to the minimum center distance (3.996 inches) plus the minimum diameter of the hole (0.750 inch) which is equal to 4.746 inches. The difference between A maximum and B minimum gives double the diameter of the pins on the inspection gage, which amounts to 1.492 inches. The diameter of these pins is therefore 0.746 inch, and the inspection gage for the relative location of the holes is identical with the one shown in Fig. 25.

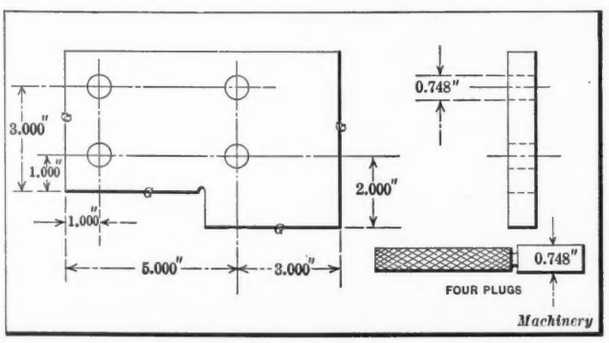


Fig. 26. Another Type of Functional Gage for Part shown in Fig. 24

In like manner, we must consider the location of these holes from the edge of the components. Call, for simplicity in notation, the dimension from the lower edge of the piece (in Fig. 28) to the upper edge of the circumference of the lower left-hand hole, C. Call the distance from the lower edge of the piece to the bottom edge of the hole D. On the gage, evidently, C must be minimum, while D must be maximum. The minimum dimension of C is equal to 0.998 inch plus half the minimum diameter of the hole (0.375 inch) which amounts to 1.373 inches. The maximum dimension D is equal to 1.002 inches minus half the minimum diameter of the hole, which equals 0.627 inch. The diameter of the pins in the gage is equal to the difference between C and D, which equals 0.746 inch. Therefore, the gage shown in Fig. 25 applies both to Fig. 24 and Fig. 28. Or, to put it in other words, Fig. 24 and Fig. 28 express the same information.

Therefore, in those cases where no tolerances are given for center distance (and this applies equally to locations of holes or grooves or slots, etc.), the minimum clearance must be analyzed, and utilized accordingly to determine the inspection gage requirements, and a suitable minimum clearance must be provided to allow for the inevitable variation in these dimensions. On the other hand, where tolerances are specified on such dimensions, these must be analyzed and applied accordingly, to establish the inspection gage dimensions, and the minimum clearance between the holes and studs must be sufficient to prevent interferences. In either case, the basic dimensions should be identical, and the inspection gages would also be identical. For conditions such as discussed above, experience will teach that the safest plan is to eliminate the tolerances from the component drawings.

The above interpretations of drawings are arbitrary to a certain extent. It would be possible to demonstrate that under certain combinations of conditions, the exact letter of the component drawings would be violated. This is inevitable in this connection. As stated before, if these solutions are accepted, the corresponding interpretations must also be accepted.

Tolerances for "Group" Locations

We will now consider the same parts, but with different functional conditions. Naturally, the holes in the companion parts must line up sufficiently to enable the studs to pass through. Therefore, the importance of the location of these

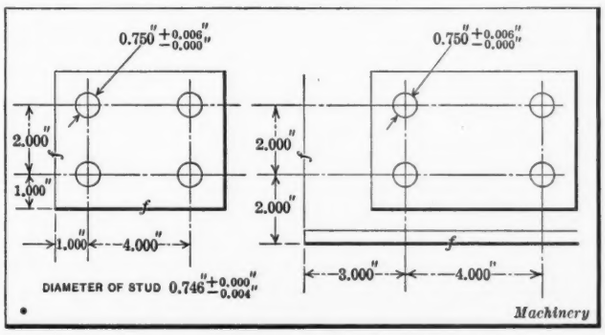


Fig. 27. Method of Dimensioning Location of Holes without Tolerances

holes in relation to each other is constant. We will assume, however, that in this case the position of the bracket on the frame is unimportant. The only method of indicating this condition that will be consistent with the general practice of dimensioning discussed heretofore will be to express a tolerance. This is done in Fig. 29. No tolerances are shown in this sketch on the dimensions controlling the relative locations of the holes to each other.

The interpretation of this drawing is that a variation of 0.040 inch, plus and minus, over and above that allowed by the minimum clearance between studs and holes is permitted on the location of the holes as a group. The inspection gage for testing this is shown in Fig. 30. This gage differs from that shown in Fig. 25 only in the addition of the steps on the edges which check the additional tolerance. It is used as follows: When the gage is held against the upper edges of the holes, the minimum lower step of the gage must not extend below the lower edge of the part. When the gage is held against the lower edge of the holes, the lower maximum step must not be above the lower edge of the part. The horizontal locations are checked in a similar manner. If the functional conditions permit a liberal variation in one direction (say, horizontal) but not in the other direction (vertical), a combination of the methods of dimensioning and checking meets the situation.

Conditions arise where the locations of holes must be established and checked from other points than a flat surface. This often requires quite elaborate fixture gages. A

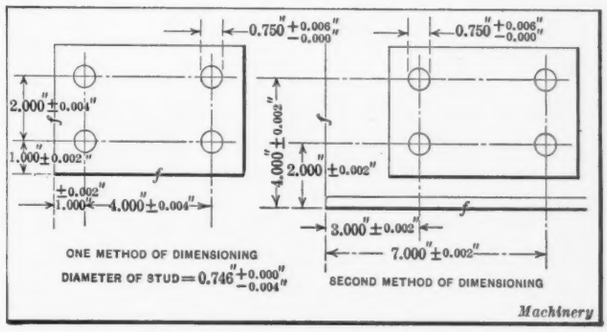


Fig. 28. Two Methods of Dimensioning with Tolerance which maintain Identical Conditions

full understanding of the preceding principles and a careful study of the particular conditions will point the way to a consistent solution of the problem. The present space is not sufficient to go into the subject in greater detail. Simple examples have been purposely selected to indicate and illustrate the general principles involved.

The preceding examples involve maintaining the relative position of several holes with each other in addition to the location of a group as a whole. In those cases where only a single hole is involved which must maintain its position in relation to elementary surfaces, the problem is simple. In most cases it can be solved by the application of methods previously discussed for elementary surfaces. In other cases, the functional requirements may be such as to demand a functional gage similar to those shown in Figs. 25 and 30.

Concentricity and Alignment

The expression of permissible variations in concentricity and alignment introduces another difficult problem. The succeeding examples offer one solution. As in the case of the locations of holes, if these solutions are accepted, the corresponding interpretations, expressed in terms of inspection gage requirements, must also be accepted.

We will assume that the stud shown in Fig. 31 must always assemble into the hole shown in the same sketch. In the process of manufacture, a certain amount of eccentricity will develop. If we attempt to give on the component drawings the permissible eccentricity in every case, the drawing will become more and more complicated. The more complicated the drawings become, the greater the possibility of undetected errors. With the following interpretations of the drawings, the conditions of eccentricity are almost automatically covered.

There is a minimum clearance on diameters of 0.004 inch between the parts shown in Fig. 31. Inspection gages to test the concentricity of these parts are functional gages and invade this minimum clearance to a fair amount. In general, this should not be over fifty per cent. The lengths of the studs and depths of the holes do not enter into this discussion. They are elementary surfaces which should be readily maintained and checked. The gages for testing the concentricity of these parts are shown in Fig. 32. It will be noted that the diameters invade the minimum clearance by an amount equal to fifty per cent. A somewhat similar

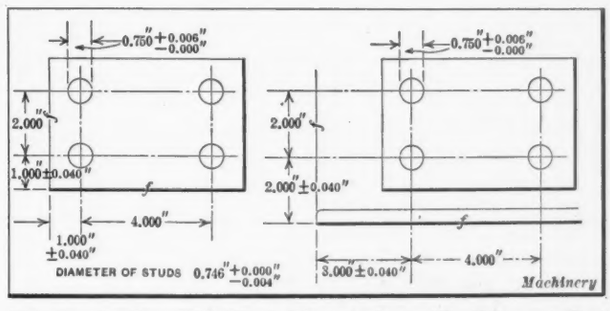


Fig. 29. Another Method of Dimensioning with Tolerance Part shown in Fig. 24

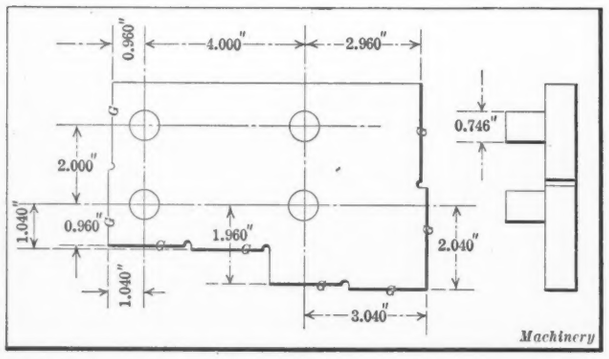


Fig. 30. Functional Gage for the Part shown in Fig. 29

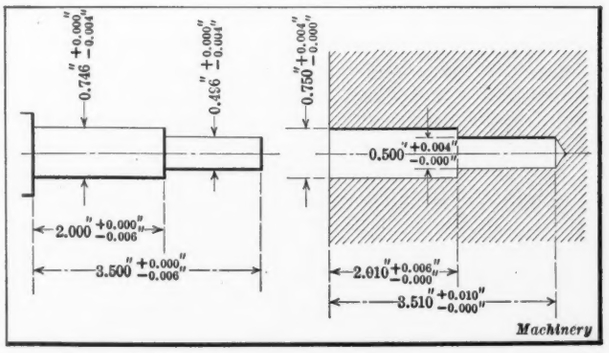


Fig. 31. Methods of Dimensioning Holes and Studs to fit

condition which involves the alignment of slides, or profile grooves and tongues, has been previously discussed in connection with Fig. 10 in the article in the November number. Functional gages for such conditions are shown in Fig. 12.

Occasionally, the situation arises where a sub-assembly as a whole must meet such conditions as are described above. This may entail individual tests for concentricity or alignment on individual component parts of the sub-assembly. The minimum clearances must, therefore, be subdivided proportionately. In such cases, it is good practice to include on the component drawing an outline with the dimensions of the functional gage required to test the conditions of concentricity or alignment. This practice will eliminate many arguments in the course of future production.

Gears

Gear teeth offer another problem of composite surfaces. In general, the tolerances on the tooth forms can best be given by specifying the permissible amount of backlash between the pair. No tolerances should ever be given on pitch diameters of gears. Specifying a limit on the backlash makes it possible to eliminate all compound tolerances. Furthermore, the most effective inspection of the gears is obtained by measuring this backlash with the gears at a fixed center distance. All the foregoing examples are comparatively simple ones. They should, however, be sufficient to indicate the manner in which a component drawing with tolerances should be dimensioned.

As stated previously, it is seldom possible at the very start to collect and record on the component drawings all of the detailed information which belongs there. The development of tools, gages, and other equipment and the final solution of many of the manufacturing problems will make apparent omissions and errors. Therefore, the component drawings should not be considered as complete until the product is actually being produced in strict accordance with them. This requires that the designer, responsible for the accuracy of the drawings, keep in close touch with both the designers of the manufacturing equipment and the various manufacturing departments in order to keep these component drawings up to date. In order better to illustrate this matter of proper dimensioning, the succeeding article will take as an example a small unit assembly and will discuss in detail the requirements of dimensions and tolerances.

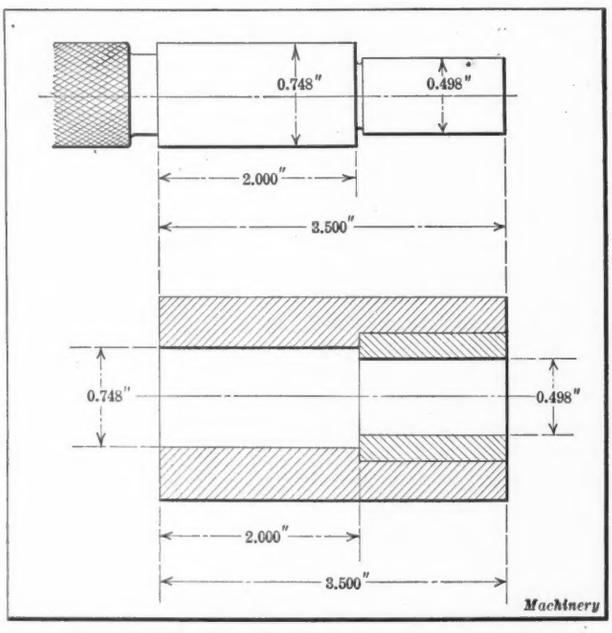


Fig. 32. Functional Gages for Part shown in Fig. 31

TESTING ALLOY STEELS

In a paper on "The Present and Future of Alloy Steels," presented before the annual meeting of the Steel-Treating Research Society by John H. Mathews, reference is made to the importance of accurate and reliable methods of testing alloy steels. When plain carbon steels were used for construction purposes, chemical analysis and tensile tests proved, in general, a fairly satisfactory indication of suitability, especially when the question of weight of construction was not of particular importance. The advent of high-powered machinery, and especially of automobiles and airplanes, resulted in a demand for material that will withstand exceptionally high stresses, and the question of lightness is of prime importance. These demands have created a wide market for alloy steels which, incidentally, are used nearly always in the heat-treated condition. The study of alloy steels, and the specific influence of the metals entering into them involves, in addition to chemical and tensile tests, microscopic methods of examination, impact tests, vibratory tests, and various other tests, the object in each case being to reveal some new information that will assist the engineer in designing for maximum efficiency and light weight. It would be desirable if non-destructive tests could be developed in order to determine the true conditions in the finished part without destroying it and without assuming that the material of the finished part is the same as indicated by tests made on samples from other portions of the material. Considerable work has been done in developing magnetic methods of analysis, but so far with little promise of success, except in particular instances. Electrical conductivity values follow changes in the molecular constituents of the steel, but it is not possible as yet to interpret the conductivity tests in terms of other properties.

* * *

Flexible fabric couplings or universal joints have been used by a number of automobile and motor truck manufacturers. These flexible couplings are noiseless in operation and they yield sufficiently to cushion the shock when the clutch of a heavily-loaded truck is engaged for starting. For this reason, the parts of the transmission are not subjected to such severe stresses as would otherwise be the case. These couplings are said to be durable and strong, but their use is restricted to "straight line" drives or cases where the driving shaft is inclined at an angle of only a few degrees.

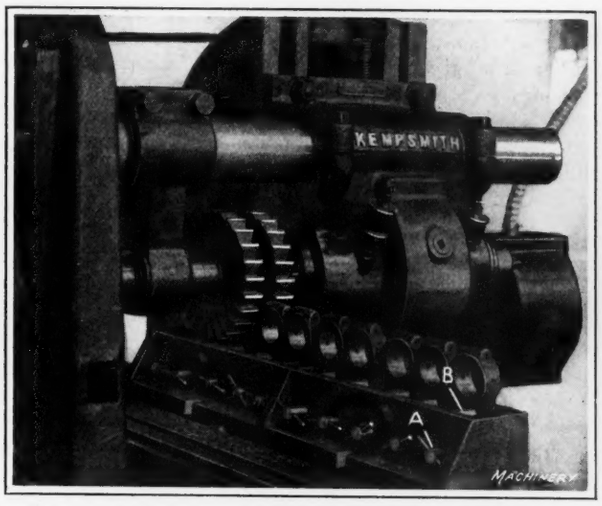


Fig. 1. Kempsmith No. 33 Lincoln Type Milling Machine equipped with Stellite Cutters for straddle-milling Gear-box Levers

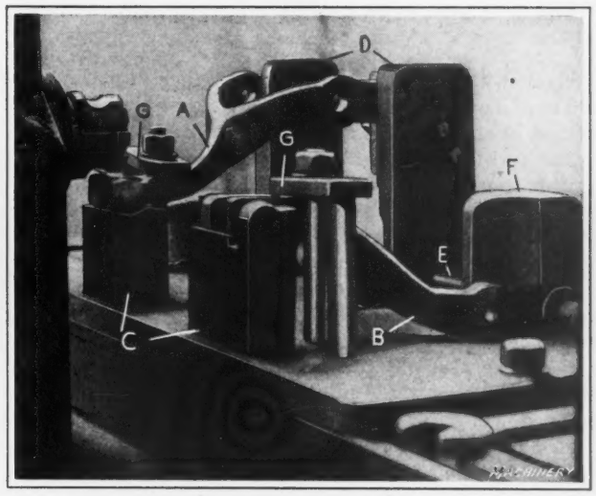


Fig. 2. Kempsmith No. 3 Plain Milling Machine equipped for milling a Convex Surface on Clutch Shifter Yoke Forgings

String Milling Fixtures

A Discussion of Typical Examples of Design and Results Obtained in Operating the Fixtures—First of Two Articles

By EDWARD K. HAMMOND

WHERE it is necessary to perform milling operations on large numbers of duplicate parts it will frequently be found desirable to make use of the familiar string type of work-holding fixture. This type of fixture may be used on practically any kind of milling machine. One of the important advantages resulting from its application is that provision is made for setting up a number of parts at a time, so that the milling machine is kept running for a considerable period before it becomes necessary to stop the spindle, unload the fixture, and return the table to the starting point. Owing to this possibility of extending the period during which the machine can be kept running without interruption, the ratio of idle time to operating time is substantially reduced.

Method of Loading String Fixtures

Variations in the conditions under which milling machines are operated will make it necessary to modify the method of loading and unloading string fixtures. Where either the size of the pieces to be milled or the rate of feed that must be employed allows sufficient time while a piece of work is passing between the cutters to enable the operator to set up a blank in an adjacent station of the fixture, the best method of procedure in operating machines equipped with string fixtures is to unload the milled parts as soon as they have passed out of engagement with the cutters. Then after the last station on the fixture has been unloaded and the table has been returned to the starting point, the milling machine operator sets up a piece of work in the station nearest to the cutters and starts the feed mechanism. He then occupies his time in setting up pieces of work in the remaining stations, working from the position nearest to the cutters toward the opposite end of the fixture. In this way, the machine is kept idle for a minimum length of time, and the operator also wastes a very small part of his working day. It frequently happens, however, that the pieces to be milled are so small or that the rate of feed is so high, that insufficient time is allowed, while one piece of work is fed between the cutters, to allow the operator to set up a piece in the next station. Under such conditions, it is necessary for several of the stations to be loaded or for the fixture to be completely loaded, before the feed is engaged; but even when such conditions are encountered, a substantial reduction on production time will be effected through the use of string fixtures, as compared with many other types of fixtures in which only one piece can be set up at a time, and where it is necessary to stop the machine and return the table after each separate piece has been milled.

Milling Kempsmith Gear-box Levers

There are several interesting features of the milling operation which is shown in Fig. 1. Not only does this illustration show a good example of string fixture design, but the job is also of interest because the cutters are made of stellite. The parts being milled are levers for use in the gear-box on either the No. 2 or No. 3 plain or universal milling machines built by the Kempsmith Mfg. Co., Milwaukee, Wis. This firm has large numbers of these levers to manufacture, and a method of performing the milling operation on a quantity production basis has been developed, which would compare favorably with the best results obtained in automobile plants and other establishments where the most approved methods of scientific management are supposed to exist. The machine on which this milling operation is being performed is of the Kempsmith No. 33 Lincoln type; and the string fixture holds ten castings which are straddle-milled on their opposite faces. The fixture has been so designed that the work of setting up can be very readily accomplished. There is a projection on each piece of work, which extends down into a channel in the fixture. Each casting to be milled has a transverse hole drilled through it, which is utilized as the locating point by sliding a T-head pin *A* through holes in the walls of the fixture and through this hole drilled in the work. At the opposite side of the fixture there is a set-screw at each of the ten stations, and when a casting has been located by means of pin *A*, this set-screw is tightened to provide for forcing the casting up against the finished face of a hardened steel stop *B*. It wil be evident that the simplicity of this fixture design makes it possible for castings to be set up and removed with very little loss of time. The material being milled is cast iron and the stellite milling cutters are driven at 60 revolutions per minute, which corresponds to a cutting speed of 125 feet per minute. The work is fed to the cutters at a rate of 8 inches per minute, and the rate of production obtained on this job is seventy-six pieces per hour.

Milling Clutch Shifter Forks for Kempsmith Milling Machines

Another good example of milling practice in machine tool building plants is illustrated in Fig. 2, which shows the method used by the Kempsmith Mfg. Co. in milling clutch shifter forks for use in No. 33 Lincoln type milling machines of this company's manufacture. This operation is performed on a Kempsmith No. 3 plain milling machine, which, as it will be seen, is provided with a string fixture that enables two pieces of work to be operated upon at each traverse of the table. Owing to the offset form of the forgings to be milled, it was found necessary to so design the work-holding fixture that provision could be made for supporting one piece of work as shown at *A* and the other in the position illustrated at *B*. In the case of each piece of work, it will be apparent that the end to be milled is supported on one of the blocks *C*, these two blocks being arranged to hold the ends of the two pieces of work at the same height from the table. Then to compensate for the offset form of the forgings, and also to afford means of clamping them in the fixture, it will be evident that use is made of the holes drilled in the opposite ends of the forgings. A sliding pin is passed through these holes and also through holes in blocks *D*, in order to provide for holding the end of fork *A* at such a level that its opposite end will be supported by the top of block *C*. Similarly, the piece of work shown at *B* is held by a pin *E* that slides through holes in the work and through two other holes drilled so that they will be in accurate alignment in the bottom of block *D* and in block *F*.

It will be evident from the illustration that by holding one forging with its offset end extending downward and the other forging with its offset end extending upward, the opposite ends of these two forgings are so located on blocks *C* that they may be milled by a single passage under a formed milling cutter, which produces a convex surface on the work of the required radius of curvature. It will also be apparent that posts are provided on the bed of the fixture to support two straps *G* which hold the pieces of work down on the tops of blocks *C*. In order to facilitate loading and unloading the fixture, it will be seen that these straps *G* are slotted, so that by merely giving the clamping nuts a half turn, it is possible to draw the straps back from their position over the work, instead of having to remove the nuts from their bolts in order to lift the straps off. In this way, a substantial saving is effected in the setting-up time. After the two forgings have been milled while held in the position shown in Fig. 2, they are removed from the fixture and each forging is then reset in the opposite position from that in which it was formerly located, in order to provide for milling the other side of the work. In the performance of these operations, the 3-inch formed milling cutter is driven at a speed of 92 revolutions per minute, which corresponds to a cutting speed of 72 feet per minute. The work is fed to the cutter at a rate of 1 11/16 inches per minute, and the rate of production is seventeen completely milled pieces per hour, which represents the time taken from floor to floor.

Milling Hudson Connecting-rods

After the crankpin and wrist-pin bearings have been bored in connecting-rod forgings, at the plant of the Hudson Motor Car Co., in Detroit, Mich., it is necessary to straddle-mill the top and bottom faces of the bosses in which holes are drilled for the bolts that hold the crankpin bearing cap in place, and to cut this cap off from the forging. These two straddle-milling operations and the cutting off of the bearing cap are simultaneously performed on a No. 3 heavy-duty plain milling machine, built by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, which is equipped with a fixture of the form shown in Fig. 3. This fixture is designed along such lines that it combines features of both the string and indexing types. It is primarily a string fixture, but provision has been made for performing the milling and cutting-off operations on six forgings held in one station while the six milled forgings held in the other station of the fixture are being unloaded and fresh blanks substituted in their places.

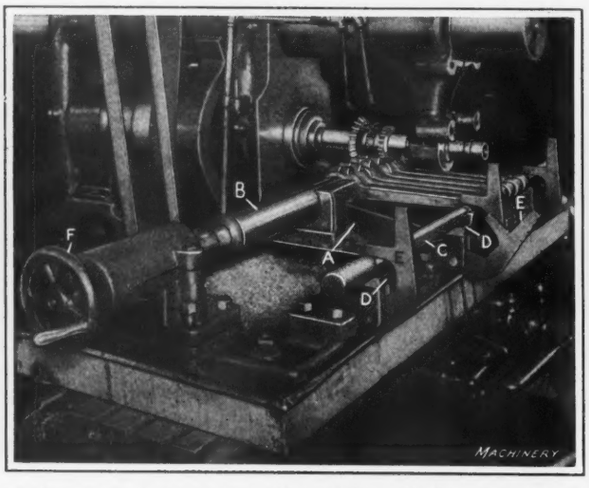


Fig. 3. R. K. LeBlond No. 3 Plain Milling Machine equipped for simultaneously milling Top and Bottom of Bolt Bosses of Hudson Connecting-rods, and cutting off Crank-pin Bearing Caps

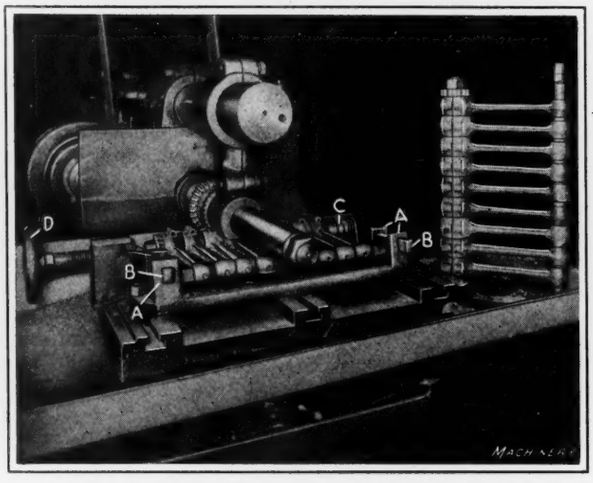


Fig. 4. Cincinnati No. 2 Plain Milling Machine equipped for straddle-milling Top and Bottom of Bolt Bosses on Continental Connecting-rods, and cutting off Crankpin Bearing Caps

Mention has already been made of the fact that when the connecting-rod forgings come to this machine, they have already had the crankpin and wrist-pin bearings bored. These two holes in the work are utilized as locating points in setting the pieces up in the fixture. It will be apparent that at a point near the center of the milling machine table, there is a bracket *A* which supports two mandrels *B* that project out from bracket *A* toward the opposite ends of the table. These mandrels are of such size that the crankpin bearing in the connecting-rods can just be slipped over them. Six pieces of work are located on each mandrel *B*, and after these six forgings have been set up, a sliding pin or bar *C* is pushed through the wrist-pin bearing holes. It will be apparent that this small bar rests on two hardened steel pads *D* and is held down by means of pivoted latches *E* which are swung up over bar *C* in order to hold it down on the pads *D* after the bar has been pushed through the wrist-pin holes in the connecting-rods. In order to afford outboard support for mandrels *B* which are called upon to support the entire pressure of the cut, it will be seen that a tail-center, manipulated by handwheel *F*, enters the outboard end of mandrel *B*, the same method of support being used at each end of the fixture.

Arrangement of Mechanism at Opposite Side of Fixture

At the opposite side of bracket *A*, there is exactly the same arrangement of mechanism, so that provision is made for setting up a complete set of forgings at each side of the central bracket, these two sides of the fixture being independent of each other. In operating this milling machine, the method of procedure is as follows: The operator sets up six forgings on that section of the fixture which is located at the left-hand side of the central bracket *A*, brings the table up to the proper level, and engages the feed mechanism. Then while the forgings carried in this section of the fixture are being fed under the cutters to provide for straddle-milling the bolt bosses and cutting off the bearing caps, the operator occupies his time in setting up a similar set of six forgings in the station of the fixture located at the right-hand side of central bracket *A*. After the milling operation has been performed on the first set of forgings, the table feeds across to bring the milling cutters into engagement with the second group of forgings. Then the operator moves over to the other side of the table in order that he may remove the milled forgings and be ready to set up fresh blanks in their places. After the operation has been finished on the second group of forgings, the table is lowered sufficiently to allow it to be traversed back to the starting point without interference from the milling cutters. The table is then raised to bring the work into proper relationship with the milling cutters, as determined by a stop, after which the left-hand side of the fixture is loaded and the feed mechanism is again engaged. This cycle of operations may be repeated indefinitely with very little loss of time for either the machine or its operator.

There is just one criticism to make of this tool design, namely, that after the bolt bosses have been milled and the bearing cap cut off at one side, the six forgings must be removed from the fixture, turned over, and again set up in the same fixture ready for performing a similar operation on the opposite side of each piece. An improvement of this condition could be made in either of two ways. If it were required to use the same milling machine which is now employed, this could be done by so constructing the fixture that the entire string of forgings could be taken out, turned over, and reset, without requiring the individual forgings to be removed from their supporting mandrel. This idea will be readily appreciated by reference to Fig. 4, in which provision is made for handling the work in just this way. An even better arrangement is accomplished at the plant of the Studebaker Corporation, where this operation is performed on a semi-automatic milling machine equipped with two spindles. With a tool of this type, the straddle-milling operations and the sawing off of the bearing cap may be simultaneously accomplished at both sides of the connecting-rod forgings, thus greatly reducing production time through eliminating the necessity of resetting the work and performing a second operation. In performing this milling operation on the machine equipped as shown in Fig. 3, the cutters run at 60 revolutions per minute, and owing to variations in their diameters they have speeds of 79, 63, and 55 feet per minute, respectively. The work is fed to the cutters at the rate of 3 inches per minute, and the rate of production is 300 connecting-rods in an eight-hour working day.

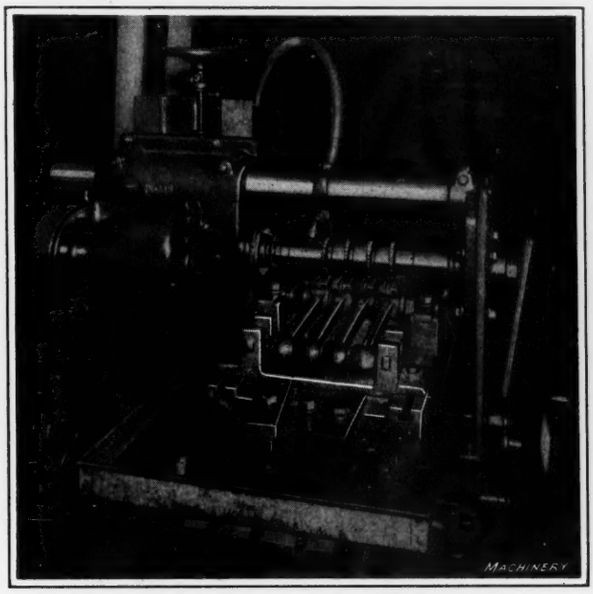


Fig. 5. Brown & Sharpe No. 13 B Lincoln Type Milling Machine equipped for roughing out the Clearance Spaces between Bolt Bosses on Continental Connecting-rods

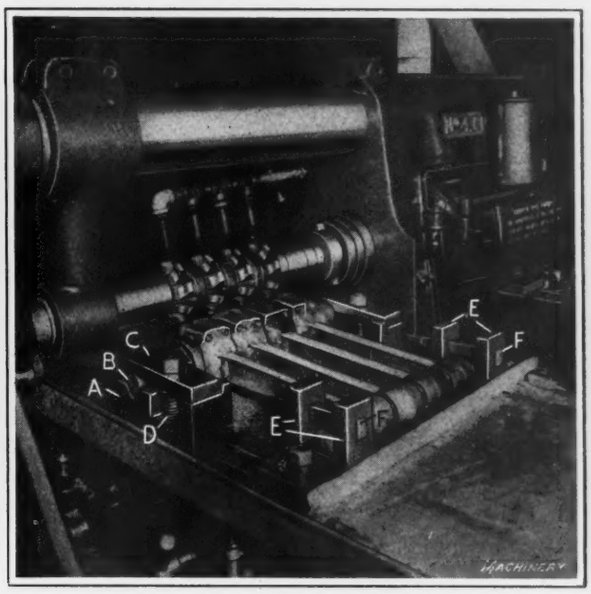


Fig. 6. No. 4 Cincinnati Milling Machine equipped with Formed Cutters for finish-milling Clearance Spaces between Bolt Bosses on Continental Connecting-rods

Milling Continental Connecting-rods

In Fig. 4 there is shown the method used by the Continental Motors Corporation, in Detroit, Mich., for performing the same milling operation on connecting-rods which is illustrated in Fig. 3. This job is done on a No. 2 miller built by the Cincinnati Milling Machine Co., of Cincinnati, Ohio. Although the methods of performing this operation which are used by these two companies are quite similar in their essential principles, the plan of setting up the work differs in several important details. Referring to Fig. 4, it will be apparent that instead of having a central bracket, with mandrels projecting out in opposite directions to provide for holding six connecting-rod forgings at each side of the fixture, the means provided on this machine make it possible to set up a string of nine forgings on two mandrels through the crankpin and wrist-pin bearing holes. These mandrels are entirely separate from the body of the fixture, so that the work and mandrels may be removed as a unit and turned over to enable a straddle-milling and cutting-off operation to be performed on the opposite side of the work. Such a unit can, of course, be much more quickly removed and set back in the fixture than is possible where individual forgings must be taken off the mandrels and put back separately after being turned over. The mandrel which passes through the wrist-pin bearings in the rods is squared, so that it may be dropped into place between yokes *A* at opposite ends of the fixture, and held down on finished seats machined in these yokes by means of tapered pins *B*. The mandrel which passes through the crankpin bearings is centered at its ends, so that it may be supported by means of a fixed center *C* and an adjustable center which is manip-

ulated by handwheel *D*. It will be seen that the form of the milling cutters and method of mounting them on the arbor are the same as in the equipment described in connection with the preceding illustration. This operation is performed at a cutting speed of 94.2 feet per minute, with a feed of 2.30 inches per minute. The rate of production is forty completely milled connecting-rods per hour, or 320 in an eight-hour day.

Milling Clearance between Bolt Bosses on Connecting-rods

On some types of connecting-rods for motors made by the Continental Motors Corporation, a practice is made of milling out the clearance between bosses provided for bolts that

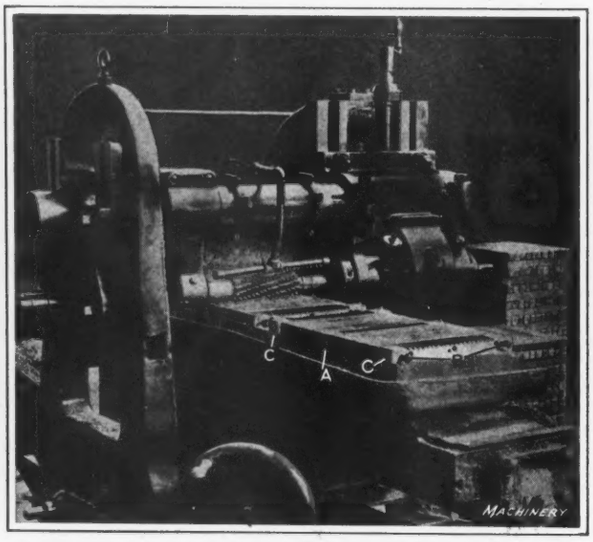


Fig. 7. Kempsmith No. 33 Lincoln Type Milling Machine equipped for milling Teeth of Racks, at the Plant of the Walker Mfg. Co.

secure the caps in place on the connecting-rods, instead of forging these bosses on the work. For the performance of this clearance milling operation, use is made of two machines which perform a roughing and a finishing operation, respectively. The machines used for this purpose are illustrated in Figs. 5 and 6. Fig. 5 shows a No. 13B Lincoln type of machine built by the Brown & Sharpe Mfg. Co., Providence, R. I., on which the first operation is performed; and after this miller has done its work, the two mandrels on which four connecting-rod forgings are carried, are removed from the machine with their work as a single unit, and transferred to the No. 4 Cincinnati milling machine, illustrated in Fig. 6, on which the four forgings are set up ready for the performance of the finish-milling operation in the clearance grooves. As the mandrels on which the work is carried are transferred from one machine to the other, it will be apparent that the work-holding fixtures used on both machines must be of the same design. The only difference in the equipment of these two machines is that plain milling cutters are used for the roughing operation, while formed cutters are employed for finishing the grooves. The best idea of the work-holding fixture will be gathered from Fig. 6, to which attention is called in connection with the following description.

Forgings which are to have milling operations performed on them by the machines shown in Figs. 5 and 6 are clamped to the mandrel which passes through the crankpin bearings. This mandrel has a collar at one end, and it is threaded at the opposite end; but in order to facilitate assembling forgings on the mandrel, the clamping nut is made of such a size that it will pass through the crankpin bearing. A C-shaped washer slips under this nut, the washer being of sufficient size so that it affords a bearing surface on which the pressure of the nut is applied to the work, in order to clamp it firmly against the collar at the opposite end of the mandrel. At the wrist-pin end, the connecting-rod forgings are held on a small mandrel which is merely a sliding fit through these bearings without being clamped in place, the function of this mandrel being merely to support the end of the forgings and hold them in the desired alignment. Mention has already been made of the fact that four connecting-rods are assembled on these two mandrels to constitute a unit which may be removed from the machine on which the first operation is performed and transferred to the second machine. Attention has also been called to the fact that on both machines, the design of the work-holding fixture is the same.

Reference to Fig. 6 will show that at the front end of the fixture there are V-blocks *A* which hold the round ends of mandrel *B* on which the work is clamped. A strap *C* at each end of the mandrel provides for holding it down in the V-block, and it will be noticed that a compression spring *D* is placed under each of these straps so that when the nut is loosened, the strap is raised, without requiring any attention from the operator. The mandrel which passes through the wrist-pin bearings in the connecting-rods is squared at each end to rest on hardened steel pads placed between blocks *E*. When the mandrel is dropped into place, two wedges *F* are driven into openings in the blocks *E* to provide for holding the squared ends of this mandrel down on their seats in the fixture. On the roughing operation, the cutters are driven at a speed of 60 feet per minute, and the rate of feed employed is 1 1/4 inches per minute. On the finishing operation, the cutters are driven at 42.8 feet per minute, and the rate of feed employed is 2 1/4 inches per minute. On each operation, twenty-two connecting-rod forgings are milled every hour.

Cutting Racks on a Milling Machine

At the plant of the Walker Mfg. Co., in Racine, Wis., a No. 33 Kempsmith Lincoln type milling machine is used to cut eighteen spur teeth in racks made of steel stock measuring 1 by 1 inch. It will be evident from Figs. 7 and

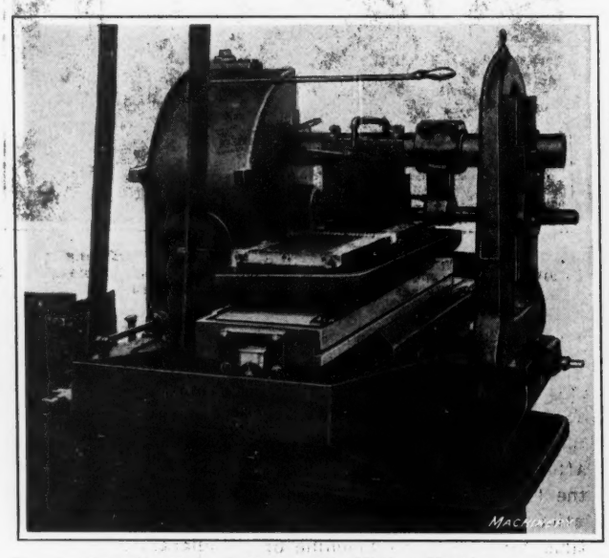


Fig. 8. Opposite End of Kempsmith Milling Machine working on the Rack-cutting Operation that is illustrated in Fig. 7

8 that a gang of rotary gear-cutters is mounted on the milling machine arbor to provide for simultaneously cutting all of these teeth; and these cutters are set up with their teeth staggered relative to each other, the purpose being to so distribute the teeth that there will be no tendency for all of them to come into engagement simultaneously, thus setting up a "hammer blow" action.

To facilitate the work of loading and unloading this fixture, and to avoid having the milling machine operator left without employment while the machine is in operation, the fixture in which these blanks are held is made in four sections which may be loaded and unloaded independently of each other. As a result, the operator can load the first

section of the fixture and then engage the feed mechanism. Six blanks are mounted in each section of the fixture, and as the rate of feed is one inch per minute, this allows the operator six minutes in which to load the second section of the fixture. As a matter of fact, this is more time than he requires. After the last section of the fixture has been loaded, the operator goes around to the back of the machine and starts removing milled racks from the fixture, so that after the last rack comes out from under the cutters it is merely necessary to unload the last section of the fixture before the table is returned. This method of operating the machine not only reduces the idle time of the operator, but also effects a substantial reduction in the idle time of the machine. The fixture is of very simple design. Each of its four sections holds six blanks, and two sections are divided by a stop-bar *A*, against which the six pieces in each section are clamped. Set-screws *B* are carried in end bars *C*; and by tightening these set-screws, the rack blanks are clamped against opposite sides of the stop-bar *A*. The cutters are driven at a speed of 71 feet per minute, and the rate of feed employed is 1 inch per minute. On this operation, the rate of production attained is 60 racks per hour, which includes the time of loading and unloading the fixture.

Use of Milling Machine Vise as a String Fixture

At the works of the Studebaker Corporation, in Detroit, Mich., it is necessary to perform a slot milling operation in the brake-lever for the passenger car built by this company. The slot milled in these small levers must be located at an angle to the axis of the lever arm, and in order to provide for the convenient performance of this simple operation, it was found possible to utilize an ordinary milling machine vise. The work is done on a No. 3 LeBlond plain milling machine, and Fig. 9 shows a close view of the vise set on the table of this machine to provide for holding a

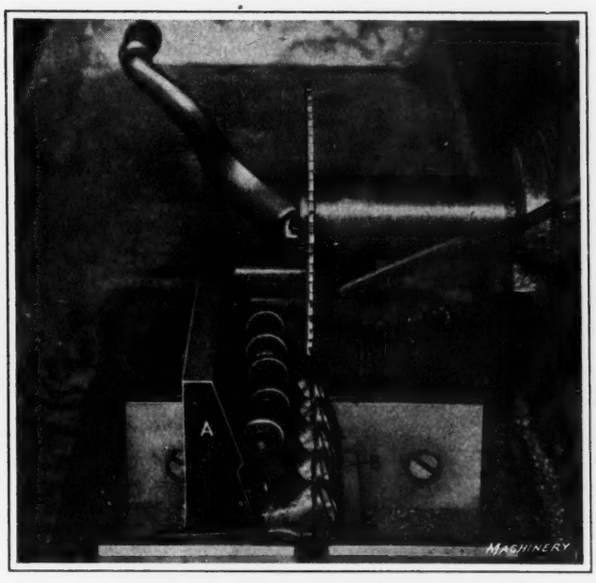


Fig. 9. R. K. LeBlond No. 3 Plain Milling Machine, used by the Studebaker Corporation for Slotting Operation on Brake-levers

string of five brake-levers. So far as clamping the work is concerned, the milling machine vise answers every requirement, but it is also necessary to locate the pieces of work at exactly the proper angle; and for this purpose, a block is bolted to the bed of the vise. This block has a face *A* that is inclined at such an angle to block *B* upon which the ends of the pieces of work rest that each piece is held at an angle which enables a slitting saw carried by the horizontal arbor in the machine spindle to cut the slot in exactly the proper position. It will, of course, be apparent that blocks *A* and *B* must be made short enough to allow the five pieces of work which are set up in the vise at a time to have a total length just exceeding the length of these five blocks. Consequently, when the movable jaw is tightened, the work is secured between the vise jaws, ready for milling. An advantageous feature of this method of holding the work is that five pieces may be set up and removed from the fixture in a very short time, the period required being only a half minute. The rate of production obtained is 75 milled brake-levers per hour.

Additional examples of string milling fixtures will be illustrated and described in the December number of MACHINERY.

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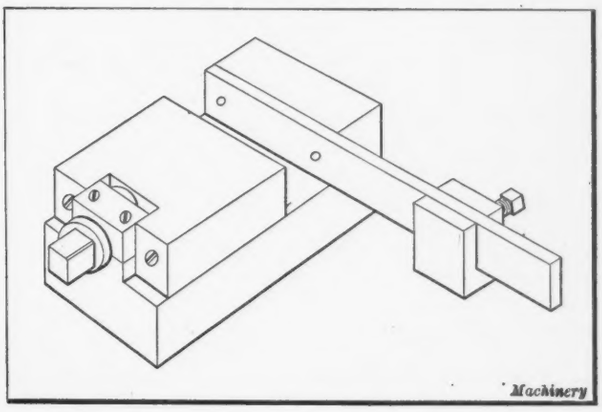
BROADENING THE SCOPE OF A MILLING MACHINE VISE

By DONALD A. HAMPSON

It is frequently necessary to perform milling operations on work that is not conveniently handled because the shop



Attachment for accurately setting Steel Bars to be milled

equipment is not adequate for the requirements of the work. Such a case occurred in a shop where it was required to finish a number of pieces of 3/4- by 2-inch cold-drawn bar steel to a length of 18 inches, within limits of 0.001 inch. The operation had to be performed on a machine that was too small to permit the pieces to be milled from the bar to the specified length, nor was the arbor long enough to permit the ends of the work to be straddle-milled, while the vise could hold but one piece at a time. Thus it was necessary to saw the pieces from the bar, allowing approximately 1/8 inch over length, finish one end of all the pieces with an end-mill or a side milling cutter, and finally finish the other ends with the same cutter. This case is typical of facing jobs where the parts are most easily held in a vise but where the vise cannot receive all of them at one loading, and where time can be saved and spoiled work avoided if some method can be devised other than the cut-and-try method, whereby all the work can be accurately machined to the same dimension.

The illustration shows the way the milling machine vise was rigged up in order to produce the work. A long jaw, which extended out from the machine was substituted for the regular standard jaw on the vise. The extended part carried a stop or gage, against which the work was held while tightening the vise. After one end of all the parts was finished, a piece of work of the correct length was used to set the stop the proper distance from the cutter, in order to finish the other end to the specified length. All of the pieces were then accurately milled to size. The same result could have been obtained by tapping a hole into the side of the vise and screwing a rod into this hole, on which the stop could have been mounted; but the practice of using regular machine parts in this manner is to be discouraged. For gaging work that is shorter than the width of the vise, a rod could be screwed into the inside of the stop, against which the work could be held. This device was inexpensive, and satisfactory results were obtained by its use.

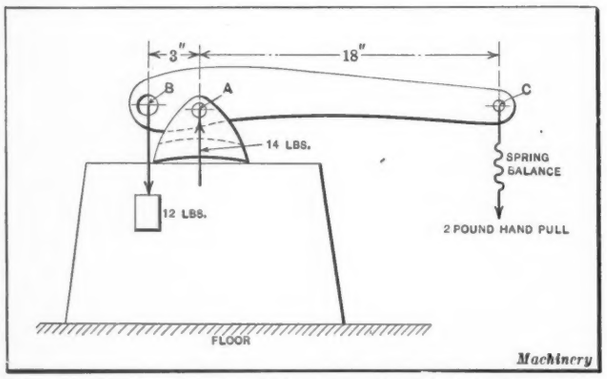


Fig. 1. Example of Simple Brake Lever maintained in Equilibrium by Known Forces

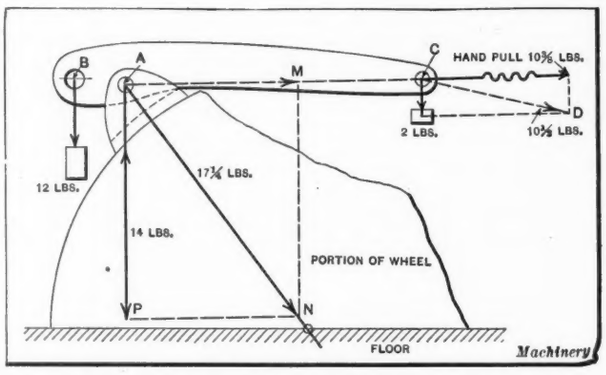


Fig. 2. Example showing Effect of Direction of Brake-shoe Pressure on Brake Rigging Design

Brake Lever Design

By VICTOR M. SUMMA, Engineering Examiner, American Brake Co., St. Louis, Mo.

WHILE the present article deals specifically with problems encountered in the design of brake levers and brake riggings for railway equipment, it nevertheless presents data and information which may be employed to advantage in designing brake levers intended for other purposes. Through some fault in design brake levers often fail to meet requirements satisfactorily, and it is the purpose of this article to present data which has been found useful in correcting mistakes frequently made when designing these parts. Before attempting to solve any practical problems, it is perhaps well to consider the theories and important principles involved in lever design. First, let it be assumed that the lever shown in Fig. 1 is made to balance itself at A; now apply a weight of 12 pounds at B, 3 inches from A. The pull of the spring balance at the point C—18 inches from A—is, of course, 2 pounds and the reaction at A, 14 pounds. While it is a well-known fact that these conditions obtain with brake levers arranged as shown in Fig. 1, the all-important principle back of it is not always followed when the levers are arranged as shown in Fig. 2. The reason for this may be that it is not thoroughly understood; therefore it is well to follow closely the simple experiment illustrated in Figs. 1 and 2 before attempting any further theoretical considerations. In reviewing the theoretical side of this problem, it is advisable to define the principle involved in terms of the following rule:

Rule—If a lever is in equilibrium, the moments of any two of the forces about the point of application of the third are equal and opposite.

Now bearing in mind that the moment of a force about a point is the product of the force and the perpendicular distance between the point and a line representing the direction in which the force acts, let the equation representing the moments about points A, B, and C of the lever shown in Fig. 3, be written as follows:

$$F \times a = R \times b = \text{moments about point } A$$
$$F \times g = Q \times e = \text{moments about point } B$$
$$Q \times f = R \times d = \text{moments about point } C$$

Now referring to Fig. 1, it will be seen that besides the well-known moments about point A, $12 \times 3 = 2 \times 18 = 36$, there are also two other identities to be considered, namely, the moments about points B and C. These may be written as follows:

$$2 \times 21 = 14 \times 3 = 42, \text{ moments about point } B$$
$$12 \times 21 = 14 \times 18 = 252, \text{ moments about point } C$$

The preceding is the analytical method of expressing the principle of the lever, but there is also a graphical method which may be defined by the following rule:

Rule—If a lever is in equilibrium and the forces acting on it are all in the same plane, the lines representing the direction in which the forces act will either meet at some point or they will be parallel with each other; these lines may represent both the magnitude and direction of the forces; also, the forces maintaining equilibrium in a simple lever such as shown at A, Fig. 4, may be represented by the so-called triangle of forces.

The simplicity of this method is shown by referring to Fig. 4. R and F in the illustration at A represent the two forces, while Q represents the reaction at the fulcrum pin. The triangle of forces shown at B is constructed by first drawing F_1 to some scale representing the magnitude and the direction of the force F; using this same scale, draw line R_1 representing force R. Now draw the line Q_1 connecting the ends of these two lines. The line Q_1 represents the magnitude and direction of the reaction Q. The preceding rules are simple, and may be easily remembered,

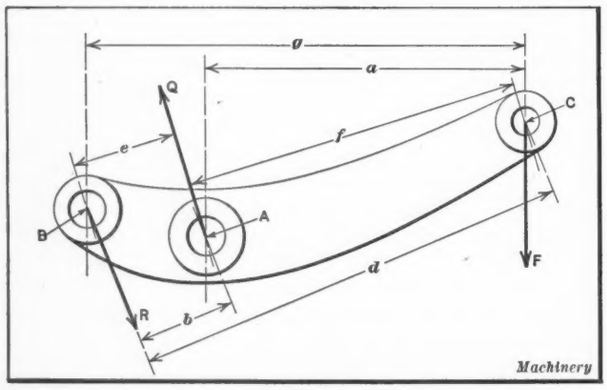


Fig. 3. Diagram illustrating Analytical Method of expressing Principle of the Lever

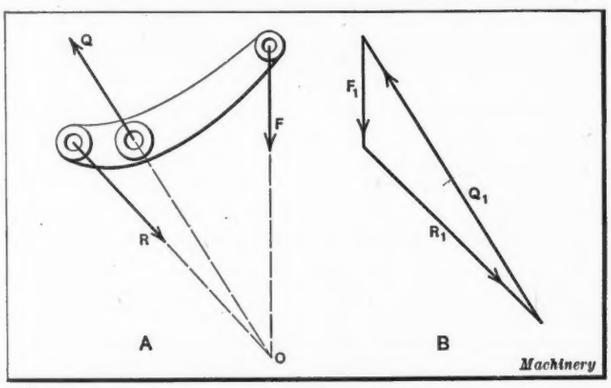


Fig. 4. Diagram illustrating Graphical Method of expressing Principle of the Lever

and are therefore to be preferred to the old-time rule which divides the levers into three distinct kinds or classes.

Bearing these essential rules in mind, we can now consider the problem illustrated by Fig. 2 which forms the main subject of the present investigation. In the arrangement shown, the 12-pound and the 2-pound weights are still required to keep the lever horizontal and perfectly balanced; the effect on the wheel, however, obviously is not the same as on the level block shown in Fig. 1. In order to prevent the lever and the shoe from sliding off the wheel, it is necessary to exert an additional pull at *C*. The spring balance will show a hand pull of approximately 10 3/8 pounds if the direction of pull is along the line *AC*, provided the surfaces of contact are sufficiently smooth. The pin *C* would therefore be subjected to a total load of 10 1/2 pounds, which is the resultant of the hand pull and the 2-pound weight; while the wheel itself would be subjected to a radial pressure in the direction indicated by line *AN* equal to 17 1/4 pounds, or the resultant of the 10 3/8-pound hand pull and the 14 pounds original pressure as given by the parallelogram of forces *MAPN*. By applying the two rules of graphics, namely, the principles of the concurrence of three balancing forces and that of the triangle of forces, these resultants can be arrived at more readily. This is shown in Fig. 5 where the forces converge in the point *O*

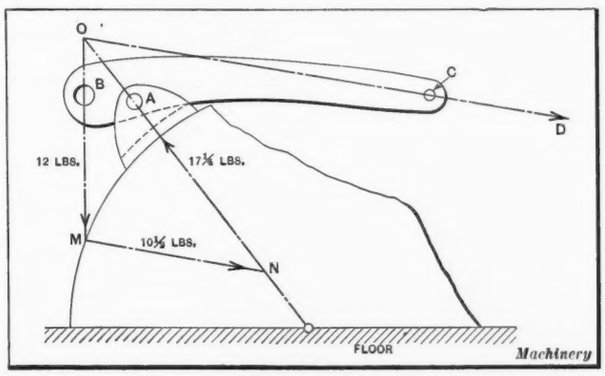


Fig. 5. Diagram illustrating Graphical Method of solving Problem shown in Fig. 2

and where the magnitude and direction of the unknown quantities may be determined by the sides of triangle *MON*.

In order to apply these rules properly, it is necessary to know the direction of the line *AN* representing the position of the shoe pressure. This is easily determined by an axiom which has been fully established in the study of mechanics, that is: *The mutual pressure between two bodies at rest acts along a common normal to their surfaces of contact.* Now for wheels and brake shoes this normal must necessarily pass through the center of the wheel. Therefore when railroad specifications call for a certain braking power, it should be universally understood that the required force is to be applied to the drivers in a radial direction. The specifications could not mean anything else, as otherwise the so-called braking power might not have the desired retarding effect on the drivers, for by simply changing the direction or the location of the pull-rods, it would be possible to obtain a wide variation in the actual braking force. From this it will be seen that specifications for the brake shown in Fig. 2 should not refer to the original 14-pound force but should specify the 17 1/4-pound radial pressure as indicated in Figs. 2 and 5. If care is not taken in this respect, skidding will result.

The actual driver brake rigging shown in Fig. 6 is materially the same as that given in Figs. 2 and 5 except that the effect of frictional force has been taken into consideration. Friction was purposely disregarded in the other problems in order to simply the experiments. Now referring to illustration *L*, Fig. 6, it will be noticed that instead of the normal force *W* we have the new force *Q* or the resultant of the braking power required and the assumed shoe friction. The pin *C* is carrying, in the direction of line *OC*, a load equal to *MN*, represented by the side of the triangle *NOM* which is paralleled to *OC*. This load is not found by combining *f* with the 2-pound load as represented by *R* in the diagram at *H*, but resultant *R'*, represented in the diagram at *K*, gives the required value, being the resultant of the force *f* and the 10 1/2-pound force. When it is realized that the loads at *C* as determined by these rules show values more than twice those obtained by the methods of calculation frequently though erroneously employed, the importance of exercising care in designing brake levers will be more fully appreciated. The difficulties experienced with brake levers designed without taking into consideration the factors just dealt with may be summed up as follows:

1. Skidding of drivers, flat tires, loss of braking energy.
2. Lack of a common standard shoe pressure between brakes designed by private companies and railroads, which prevents an intelligent comparison of their experiences and investigations.
3. Hanger-lever top pins entirely too weak.
4. The production of a second bending moment on all return hanger levers besides the usual bending moment of plain flat levers, due to the upward pull at *C*.
5. Hanger lever brackets often too weak at the root of the projecting arm.

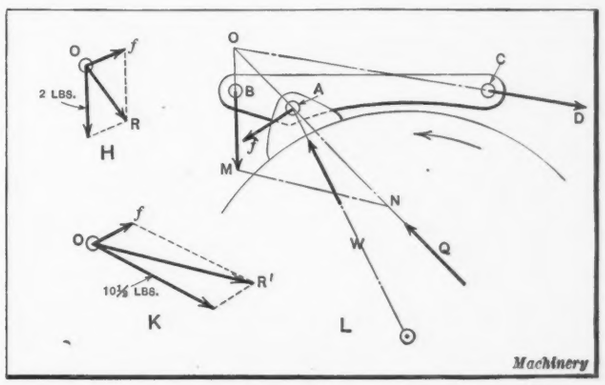


Fig. 6. Diagram illustrating Method of determining Effect of Frictional Force

6. Inadequate fastenings between hanger lever brackets and frame due to errors in calculating magnitude and direction of the force acting on pin *C*.

* * *

METHOD OF CLEANING COIL SPRINGS

By DONALD A. HAMPSON

A certain manufacturer who produces coil springs from copper-finished steel wire had considerable trouble in keeping them bright and free from oil. These springs are 2 inches long and have an extension at each end that projects at right angles to the axis of the spring. In the production of these springs, the use of a lubricant is imperative in the operation of the forming machine, which results in the presence of oil on the finished product. Unless this oil is removed, the bright copper finish of the wire becomes dull, and thus the selling qualities are lessened. This objection is now overcome by the method to be described.

The springs are packed in a wooden box having a removable cover. A 1-inch shaft passes through the box and is secured to its sides by flanged collars. The shaft is supported by a bearing on each side of the box, and carries a driving pulley on one end by means of which the box is revolved at the rate of forty revolutions per minute. After the box has been filled with springs, a quantity of sawdust is dumped in and the cover fastened on. By revolving the box for about twenty minutes, the sawdust is circulated through the springs, during which process the oil is completely absorbed and the springs are given a uniform polish. The springs tend to become tangled if the box is revolved longer than the time stated, or if the box is only partly filled.

Turret Lathe Practice

Examples of Turret Lathe Practice Based upon the Experience of the Gisholt Machine Co.
Third of a Series of Four Articles

By ERIK OBERG

IN the first two articles of this series, the machining of flywheels, auto truck wheels, tractor axle housings, wheel hubs, and motor frames was dealt with; in the present article tooling equipments and orders of operation for machining cylinders, piston rings, clutch cones, and miscellaneous parts will be described. The article on turret lathe practice in the January number of MACHINERY will deal with the machining of valves.

Fig. 1 shows the general outline of the cylinder for the Liberty truck engine, the heavy lines indicating the surfaces that are finished on the turret lathe. One operation only is required for finishing these surfaces, the tool lay-out for this operation being shown in Fig. 2, while Figs. 3 and 5 show the tooling equipment. Fig. 3 shows a complete view of the whole equipment, and Fig. 5 shows an expanding boring-bar for finishing the enlarged chamber in the bottom of the cylinder, just ready to enter the cylinder. The material from which the cylinder is made is a semi-steel casting. The step-by-step methods used in finishing this casting are as follows: (1) The work is held in a special fixture made to suit the casting, the general design of which is best seen from Fig. 5. This fixture, in turn, is bolted to the chuck of the machine. At the front part of the fixture there is a hinged arm that encloses the cylinder when it has been mounted in place. A pin or stud is inserted at the chuck end of the fixture which centers and locates the cylinder (see Fig. 2). The segment of cast iron shown at the top of the fixture in Figs. 2, 3, and 5 is simply provided to counterbalance the weight of the lower part of the fixture. (2) Surfaces *E*, *F*, *G*, *H*, and *I* (Fig. 2) are rough-machined with tools *K* and *L* in the toolpost. At the same time, bore *C* of the cylinder is rough-bored with cutters in a head on the boring-bar mounted in Side 1 of the turret. This bar is supported by means of a steady-rest, indicated in Fig. 2, having a bushing which fits the outside of the bushing *M* shown mounted on the bar.

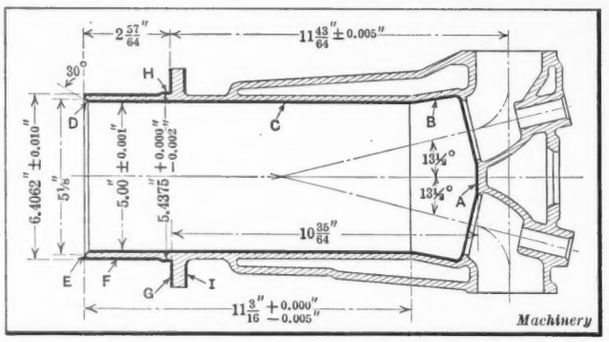


Fig. 1. Outline Section of Liberty Truck Engine Cylinder

(3) The bore *C* of the cylinder is finished with a cutter held in the bar mounted in Side 2 of the turret, this bar being supported by the steadyrest in the same manner as the bar mounted in Side 1 for roughing the bore. (4) The bore *C* of the cylinder is reamed with the reamer mounted

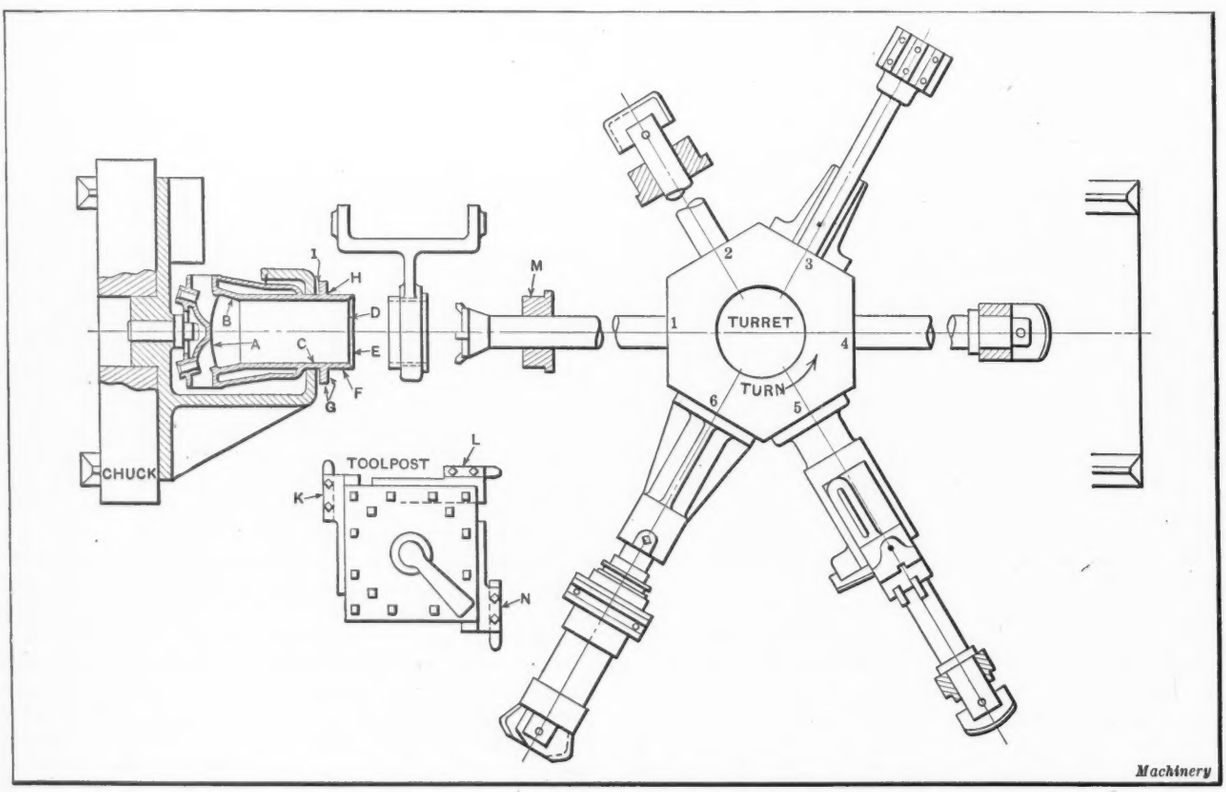


Fig. 2. Tool Lay-out for finishing Liberty Truck Engine Cylinder

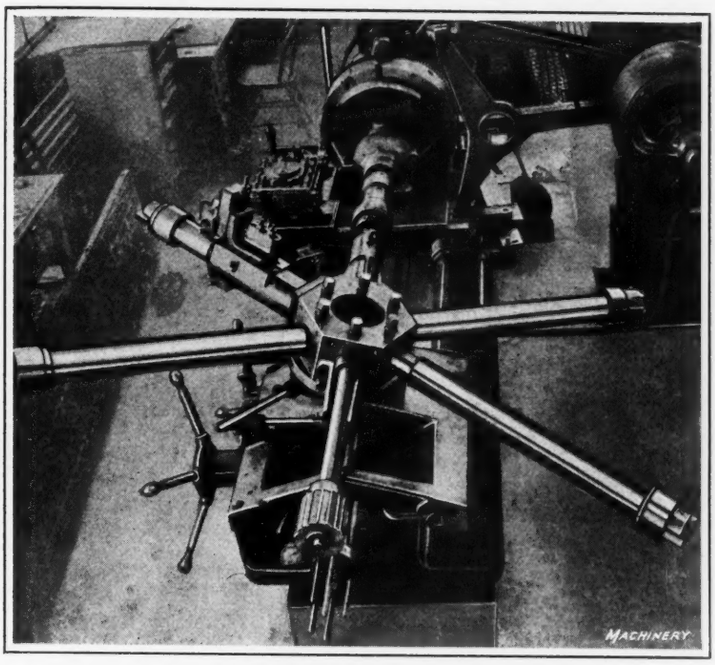


Fig. 3. Tooling Equipment for Engine Cylinder set up in Machine

in Side 3 of the turret. (5) The bottom *A* of the cylinder, or combustion chamber, is rough-faced with a cutter held in the bar mounted in Side 4 of the turret. This bar is provided with a bushing that is steadied by the bore of the cylinder itself while in action. (6) Surfaces *A*, *D*, *E*, *F*, *G*, and *H* are finished with cutters held in the facing head and bar mounted in Side 5 of the turret. (7) The bore of the cylinder, at *B*, is bored with cutters held in the bar in Side 6 of the turret. These cutters enlarge the bottom or dome of the cylinder; they are of the expansion type, so that after having entered the cylinder and reached the bottom, they may be spread, and thus machine the enlargement at the inner end of the cylinder. The bar is provided with a ball thrust collar which is connected with the cutters in such a manner that when the collar strikes the end *E* of the cylinder and the bar still continues to feed in, the cutters are caused to expand. This collar is clearly shown in Fig. 5. (8) The under side of the flange at *I* is finished with tools held in the holder *N* in the toolpost. The total time required for finishing the cylinder as outlined is 25 minutes, floor to floor time.

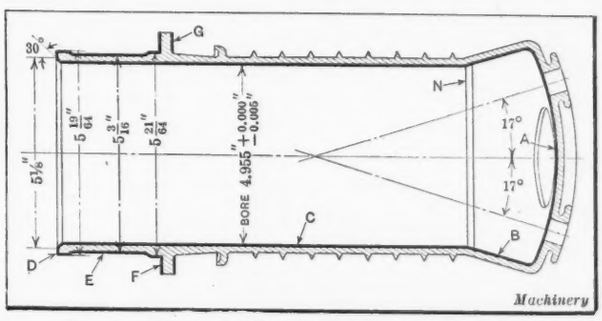


Fig. 4. Section of Liberty Airplane Engine Cylinder

Tooling for the Liberty Airplane Engine Cylinder

Fig. 4 shows a section of a Liberty airplane engine cylinder. This cylinder is made from a steel forging. It is finished in the turret lathe as indicated by the heavy black lines. Fig. 6 shows the tool lay-out, while Fig. 7 shows a view from above, indicating the arrangement of the tools and showing the expansion boring-bar, which is of the same type as that shown in Fig. 5. Fig. 8 shows a detail view, indicating how the cylinder is held in a special fixture.

The operations performed on the cylinder are as follows: (1) The cylinder is held in place in a fixture provided with special hard jaws, gripping it at the lower end; screws support it toward the outer end as indicated in Fig. 6. (2) Surfaces *D*, *E*, *F*, and *G* are rough-machined with tools *H* and *I* held in the toolpost. At the same time, the bore *C* is roughed out with the cutters held in the bar mounted in Side 1 of the turret. This bar is provided with a bushing which enters into a steadyrest supporting it while in action. This steadyrest is not shown in its working position in the illustrations Figs. 7 and 8. (3) Bore *C* of the cylinder, Fig. 6, is reamed with the reamer held in Side 2 of the turret. (4) The concave bottom *A* of the cylinder is roughed out with a cutter held in the bar mounted in Side 3 of the turret. This bar is supported, after it has entered the work, by a bushing guided by the previously reamed bore of the cylinder. (5) The bottom of the cylinder at *A* is finished with a cutter held in the bar mounted in Side 4 of the turret. This bar is supported in the same way as the bar used for roughing the cylinder bottom. A tool is also provided on this bar for finish-facing the end *D* of the cylinder. (6) The enlarged bore at the end of the cylinder, at *B*, is finished with an expanding cutter mounted in Side 5 of the turret. This cutter is expanded in the same manner as that shown in Fig. 2 and described in connection with the tool lay-outs and the operations for the Liberty truck cylinder. The total time required for the various steps in finishing the Liberty airplane engine cylinder shown in Fig. 4 is 30 minutes. The two examples of cylinder work shown indicate what can be done along this line on the turret lathe.

Fig. 9 illustrates a machine arranged for making concentric piston rings in the turret lathe. The casting from which the rings are made is clearly shown in Fig. 10, held in the chuck of the machine. The casting has a chucking flange at the rear end, cast solid with it, this flange being at an angle of 15 degrees, and the jaws of the chuck are bored to fit this flange. The work performed on the casting consists in boring, turning, and cutting off the rings. A special rear toolpost is used in this case, and a right- and left-hand feed-screw is provided passing through to the rear

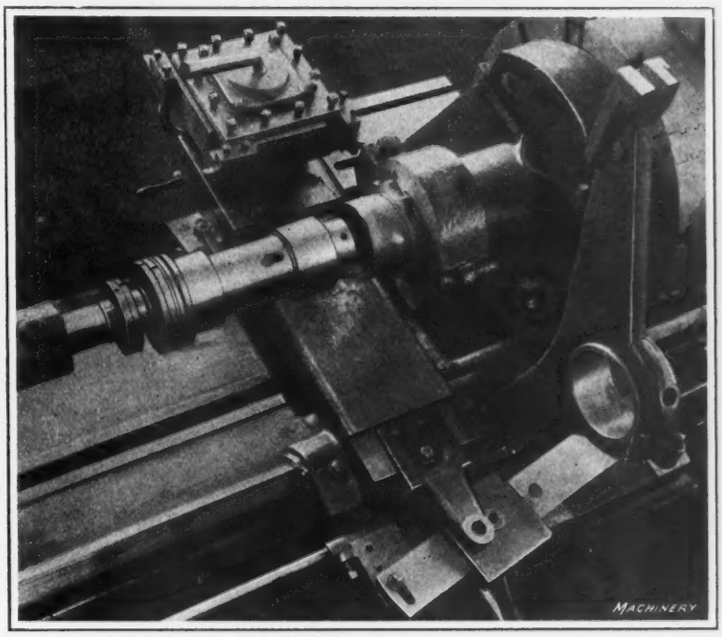


Fig. 5. Liberty Truck Engine Cylinder set up in Machine

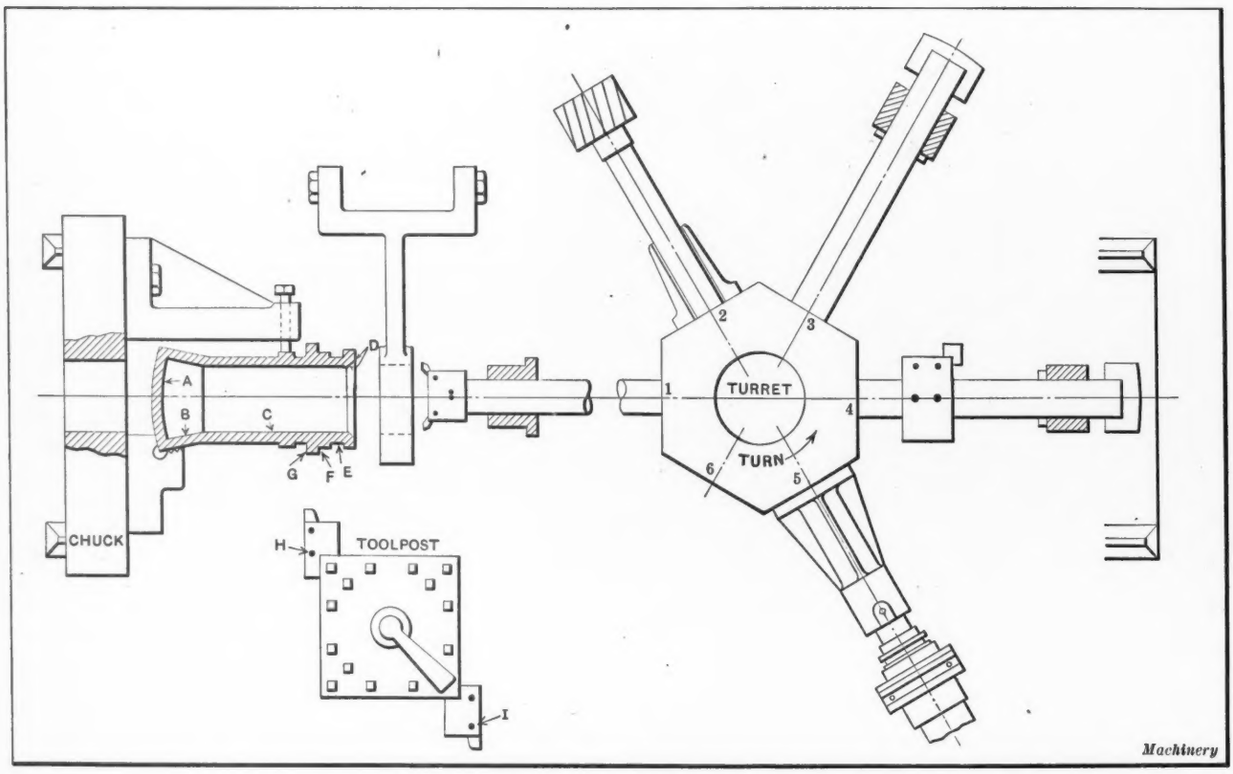


Fig. 6. Tooling Lay-out for Cylinder shown in Fig. 4

toolpost. By this arrangement it is possible to use both the front and rear toolposts for rough-turning, simultaneously. This arrangement balances the cut and prevents unequal strains on the castings, and it makes but one cut necessary, no finishing cut being required, as the rings must be re-turned after having been split and sprung together.

At the same time as the turning of the outside of the casting is being completed, a boring-bar with two cutters enters the bore. The end of this bar is supported in a bushing in the chuck. The boring head is of the adjustable type, so that one head will take care of several different sizes of bores; hence, a complete line of piston rings may be made with a comparatively small tool equipment.

The next step is to finish-bore the inside of the casting, after which a multiple cutting-off tool-block held in the front toolpost is brought into use. This multiple tool-block may be seen both in Figs. 9 and 10 on the outside of the toolpost, which is indexed to a working position before the multiple cutting-off tool is brought into action.

Machining a Clutch Cone Gear

Fig. 11 shows a clutch cone gear which is machined on all the surfaces indicated by heavy lines in the illustration. The work is performed in two operations, tooling equipment and the means for holding the work being shown in Fig. 13, for the first operation, and in Fig. 14 for the second operation. It will be noted that in the first operation the clutch cone is held by the large conical end next to the chuck, special chuck jaws bored to fit the outside tapered surface being employed. In this operation, the hub is faced, the hole is bored, and the front end and the outside of the gear are machined.

The clutch cone gear is then turned around and held as shown in Fig. 14, the machined outside circumference of the gear being gripped and the work held in position by soft jaws. The outside tapered surface of the clutch cone is rough- and finish-turned by tools held in the toolpost. The inside tapered surface is bored by a special taper-boring head illustrated in Fig. 15. The inside and the outside are bored and turned simultaneously as indicated in Fig. 14, where both the turret tools and the toolpost tools are shown in action.

In Fig. 15 a clutch cone part is shown in section in order to illustrate the action of the taper-boring head. The cone shown is of slightly different design from that illustrated in Fig. 11, but the principle of the action of the head is the same. The taper for the friction is bored with a single-point tool,

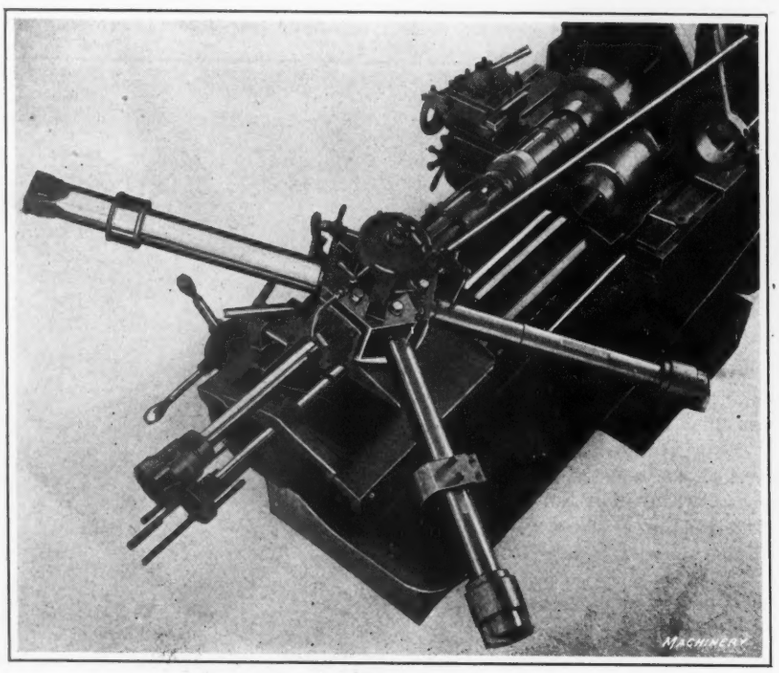


Fig. 7. View of Tooling Equipment for Cylinder shown in Fig. 4

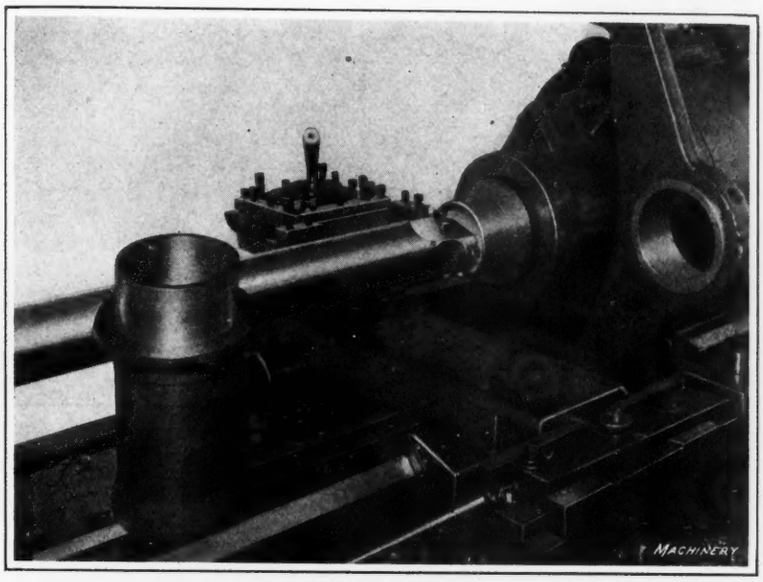


Fig. 8. Detail View showing Cylinder held in Special Fixture

properly guided in order to insure a correct angle. A pilot enters the bushing on which the clutch cone is centered, insuring that the friction cone will be concentric with the bore in the hub. A ball thrust bearing is provided at *A* which bears against the end of the bushing in the chuck and thereby prevents the pilot from entering further into the hole; by this means the tool is properly located with relation to the tapered surface. As the head is fed forward over the pilot, a pin resting against the angular surface *B* guides the tool in at the correct taper, the slide holding the tool being forced down by a spring as the head feeds inward.

In performing the second operation, the recess at *A* in Fig. 11 is cut with the tool held in the long tool-holder shown clamped in the toolpost at the front in Fig. 14. This recess must be finished in order to provide clearance for the tool in the taper-boring head mounted in the turret. The total time required for the first and second operations, completely finishing the clutch cone gear, is 60 minutes. The clutch cone is also finished on the turret lathe in the manner described in the following.

Machining the Clutch Cone

Fig. 12 shows a drawing of the clutch cone which fits the clutch cone gear shown in Fig. 11. This cone is finished on the surfaces indicated by heavy lines. The material is cast iron. The work is completed in two operations, Fig. 17 showing the method of chucking and the tooling equipment for the first operation, while Fig. 18 shows the set-up for the second operation.

In the first operation (Fig. 17), the clutch cone is held in the chuck by special chuck jaws which grip it on the inside at the small end of the taper. The outside of the clutch cone is then rough-and finish-turned with tools held in the toolpost, and at the same time the inside is rough- and finish-bored and reamed by the tools held in the turret.

In the second operation, the work is held by soft chuck jaws on the outside of the large end of the tapered surface, as shown in Fig. 18. The small end of the cone is then faced by a tool held in the toolpost, which completes the operations. The total time required for both operations is 25 minutes.

Machining a Tractor Driving Axle Arm

Fig. 16 shows an irregular piece machined on a 24-inch Gisholt turret lathe. The greatest difficulty in handling pieces of this kind is met with in deciding upon the proper holding and clamping means. This arm is machined as indicated by the heavy lines. The material is cast iron. In the first operation, a diagrammatical illustration of which is shown in Fig. 19, the work is held on a special angle-plate

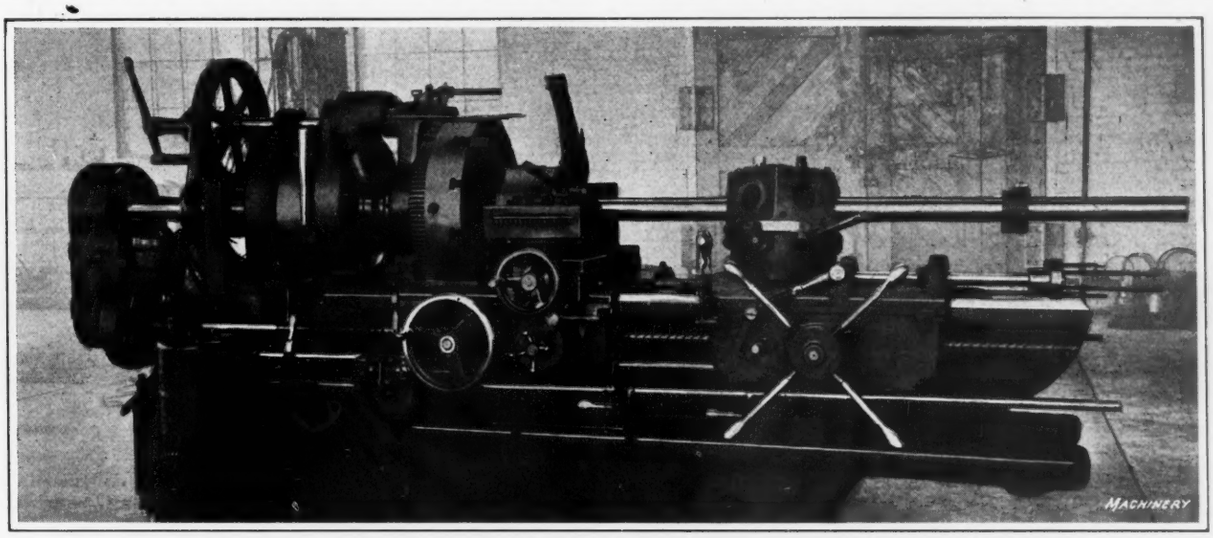


Fig. 9. Machine set up for making Concentric Piston Rings

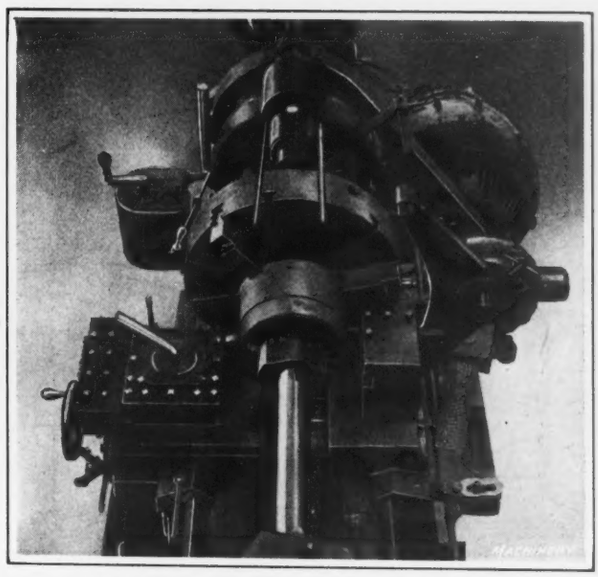


Fig. 10. Casting from which Piston Rings are made, held in Chuck

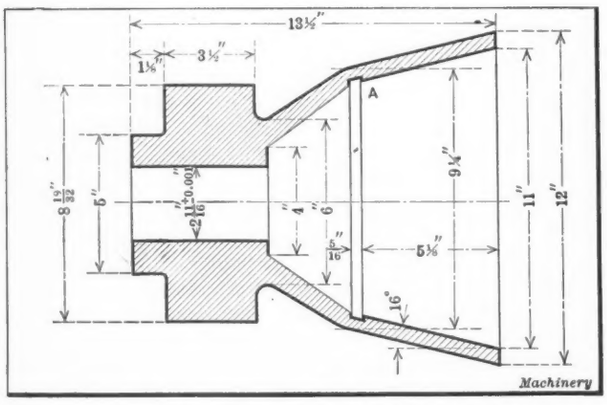


Fig. 11. Clutch Cone Gear to be finished in Turret Lathe

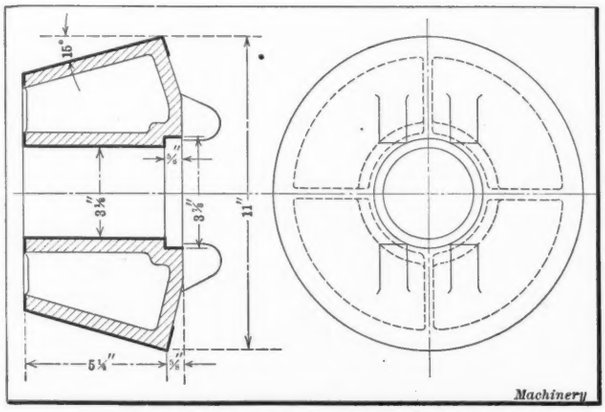


Fig. 12. Clutch Cone to be finished in Turret Lathe

in V-blocks, and rough- and finish-machined on the surfaces *A* and *B* with tools held in the toolpost. The time required for this operation is 9 minutes.

The second operation, the tooling lay-out of which is shown in Fig. 20, consists in boring the hole in the outward end of the arm and facing the flange, as well as facing the rear side of the hub at *E*. The step-by-step order of operations is as follows: (1) The work is placed in a special fixture, the main features of which are indicated in Fig. 21, and held by clamps forcing the finished bottom flange against the chuck plate. In addition, an auxiliary supporting clamp is used, steadying the arm near the end where it is machined. (2) Flange *C*, Fig. 20, is rough-faced with tool *F* in the toolpost. (3) Hole *D* is rough-bored with cutters held in a bar mounted in Side 1 of the turret. (4) Hole *D* is finish-bored by cutters held in a bar mounted in Side 3 of the turret. (5) Hole *D* is reamed with a reamer held in Side 5 of the turret. (6) Face *C* is finished with tool *G* in the toolpost. (7) The rear face *E* of the hub is faced with a tool held in the bar *H* mounted in the toolpost. This bar is clearly shown in the front of the toolpost, Fig. 21. The total time required for the second operation is 9 minutes.

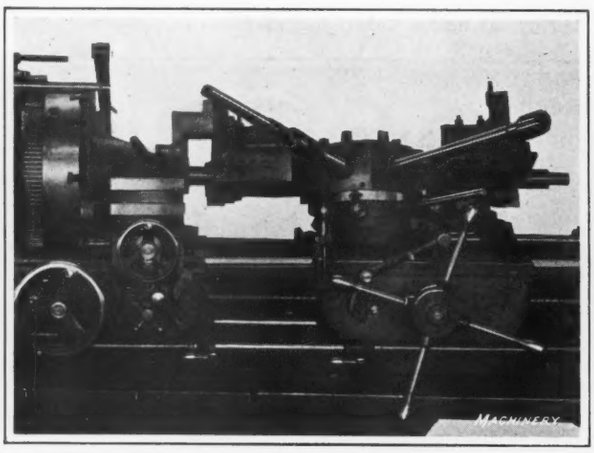


Fig. 13. Equipment for First Operation on Clutch Cone Gear

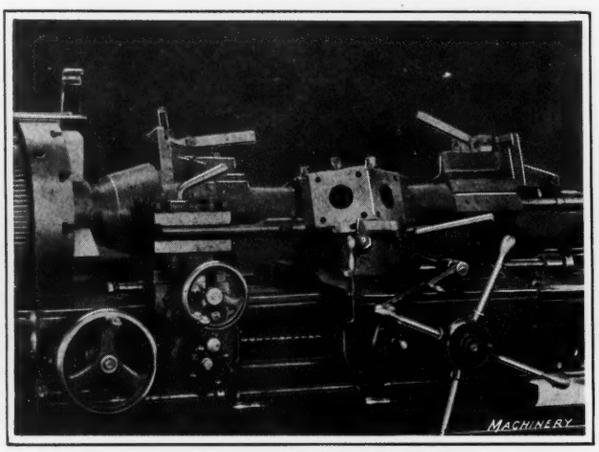


Fig. 14. Equipment for Second Operation on Clutch Cone Gear

As mentioned in a previous installment, the turret lathe is sometimes not kept fully busy on the work for which it has been procured and for which it is especially adapted.

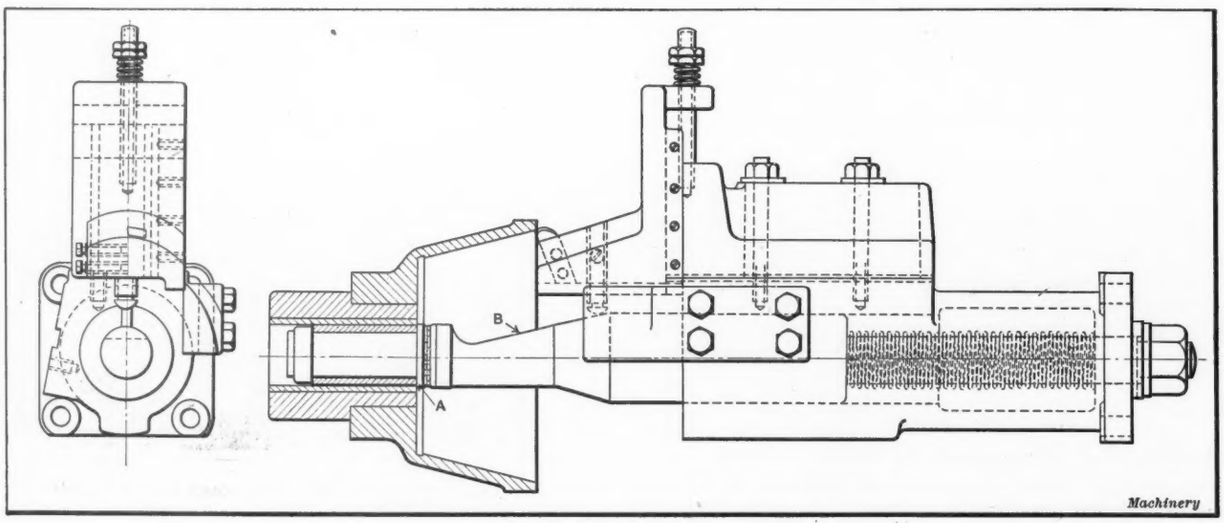


Fig. 15. Taper-boring Head for boring Clutch Cone Gear in Fig. 11

In cases of that kind, it is of advantage to use the turret lathe for other work for which the machine might not have been purchased, if there had been no other work to do, but which, when the machine is available, can be performed on the turret lathe more rapidly and, therefore, more cheaply than on other machine tools. An example of work of this kind is illustrated in Fig. 22, where the turret lathe is shown employed in facing the flange of a steam trap. Later operations include the drilling of holes in the same trap. The material is cast iron, and the work is performed in a 21-inch Gisholt turret lathe. The first operation, as illustrated in Fig. 22, simply consists in holding the steam trap by hard jaws supporting

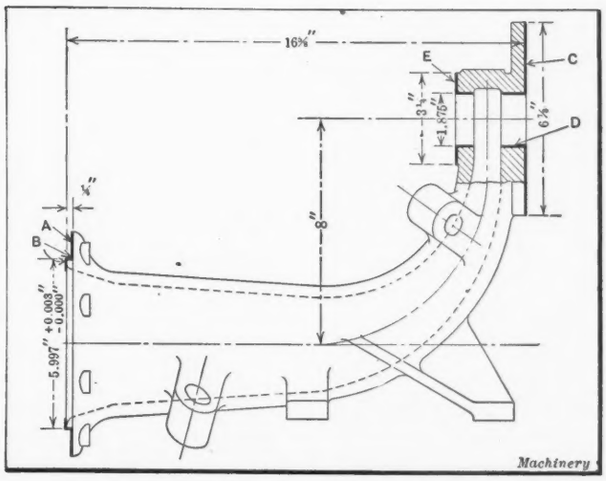


Fig. 16. Irregular Piece machined on the Turret Lathe

it at the rim of the flange, and then facing the flange with a tool held in the toolpost, as indicated. The time required for this operation is 3 minutes.

Fig. 23 shows the second operation, in which a hole is drilled and tapped at each end of the hub at the bottom of the trap. The tooling equipment of the turret lathe simply consists of a drill and a tap held in opposite faces of the turret. The work is mounted on an angle-plate fastened to the chuck, the steam trap being held on this plate by clamps bearing upon the flange. A counterweight is used on the chuck to balance the weight of the angle-plate and the trap. The hole is then drilled and tapped first from one side and then from the other. The total time required for the operation is 6 minutes.

The third operation is illustrated in Fig. 24, where a hole near the flange of the trap is drilled and tapped by a tooling equipment identical with that illustrated in Fig. 23. The trap is held on an angle-plate with clamps, the same as in Fig. 23, but no counterweight is required in this instance, because the top part of the trap projects beyond the center of rotation and balances the angle-plate. The clamping,

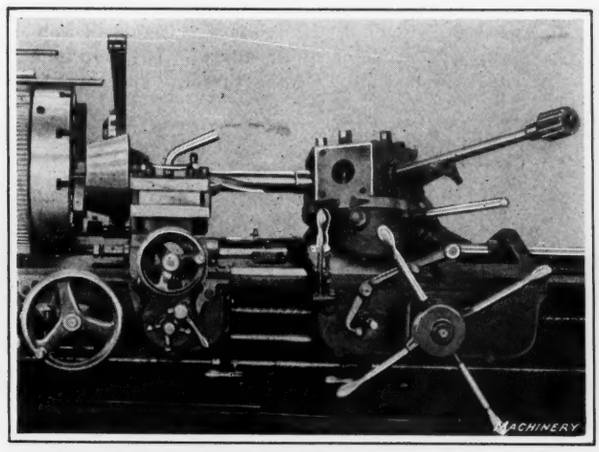


Fig. 17. First Operation on Clutch Cone shown in Fig. 12

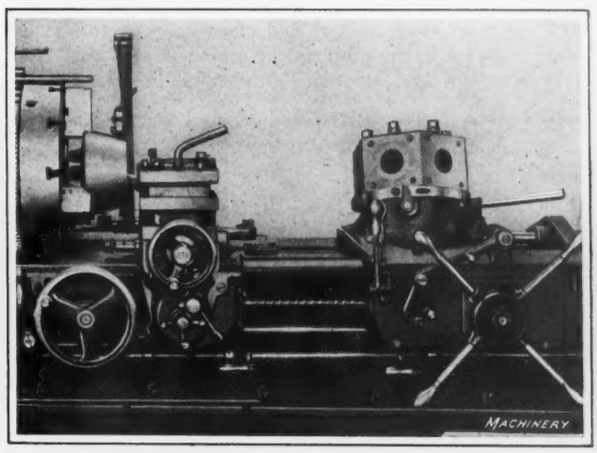


Fig. 18. Second Operation on Clutch Cone shown in Fig. 12

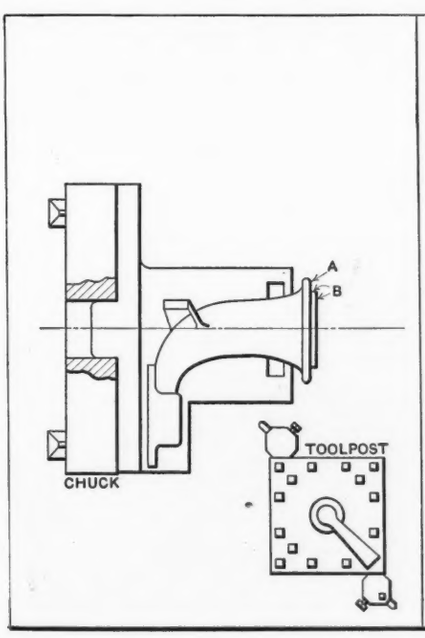


Fig. 19. First Operation on Piece (Fig. 16)

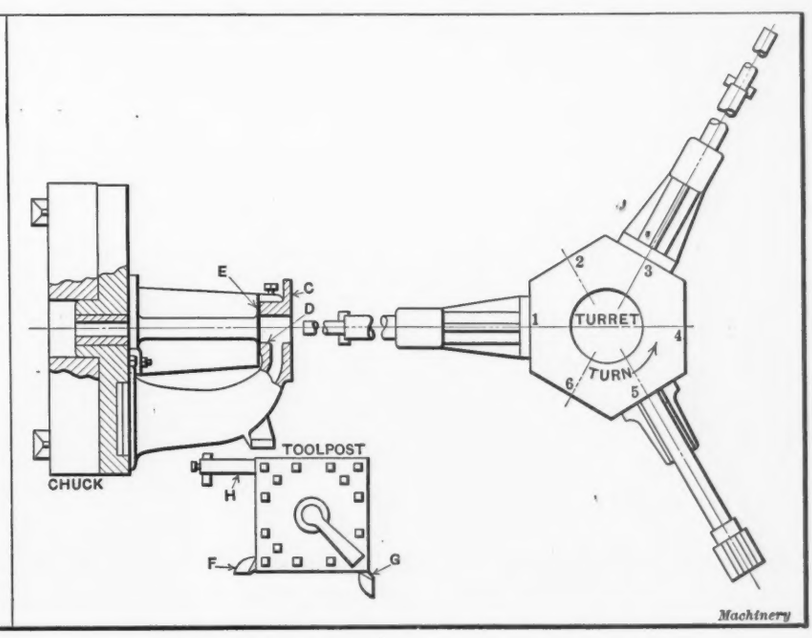


Fig. 20. Second Operation on Irregular Piece in Fig. 16

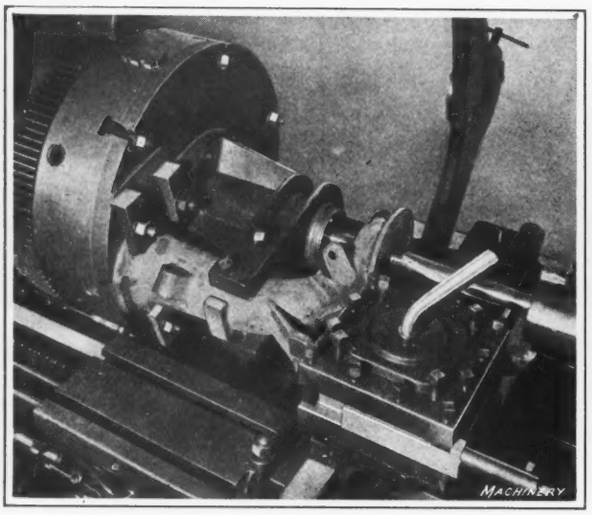


Fig. 21. Holding Piece (Fig. 16) for Second Operation

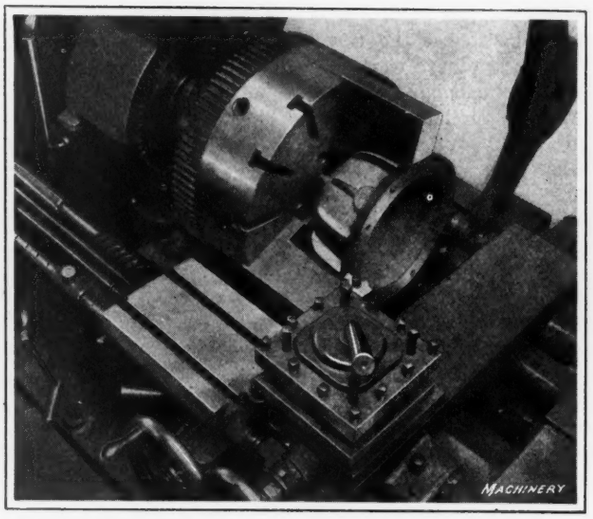


Fig. 22. First Operation on a Steam Trap—Facing the Flange

drilling, tapping, and removal of the trap from the machine requires a total time of 3 minutes.

Figs. 25 to 28 show similar odd operations performed on a steam trap cover the material of which is also cast iron. In this case, the first operation illustrated in Fig. 27 consists in facing the flange of the cover with a tool held in the toolpost, the cover being held by hard jaws as shown. The total time for the first operation is 3 minutes.

The second operation, the tooling lay-out for which is shown in Figs. 25 and 28, consists of five steps as follows: (1) Chuck the work by special eccentric jaws, holding it by the outside rim, as indicated in the illustrations. (2) Rough the boss *C* with tool *F* held in the toolpost. (3) Finish the boss *C* with tool *G* held in the toolpost. (4) Drill hole *D* with the drill held in Side 1 of the turret. (5) Tap hole *D* with the tap held in Side 4 of the turret. The total time required for the second operation is 6 minutes.

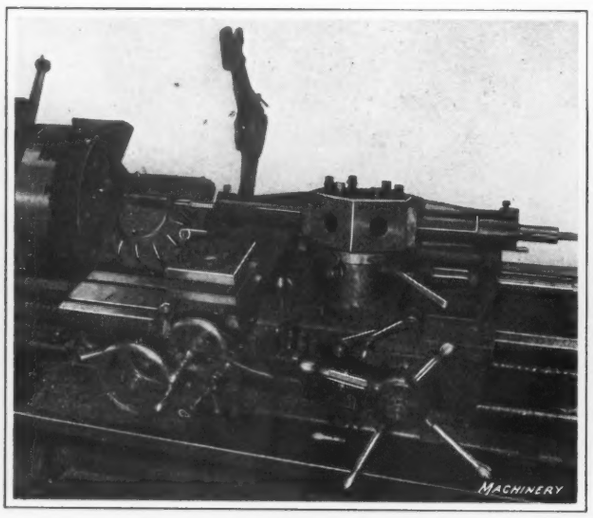


Fig. 23. Drilling and Tapping Hole in Steam Trap

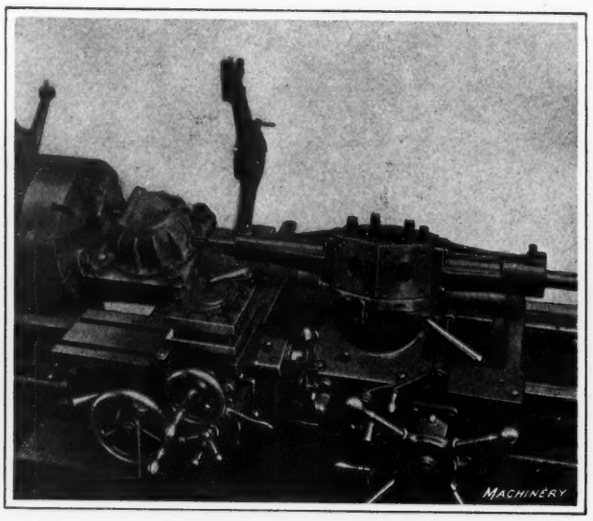


Fig. 24. Another Drilling and Tapping Operation on Steam Trap

The third operation consists simply in drilling and tapping a hole in the cover, as indicated in Fig. 26. The cover is held on an angle-plate by clamps as shown, a counterweight being used on the chuck to balance the weight of the angle-plate. The time required is 4 minutes.

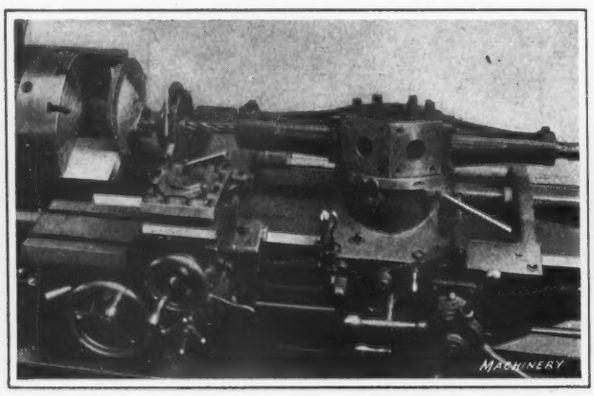


Fig. 25. Equipment for Second Operation on Steam Trap Cover

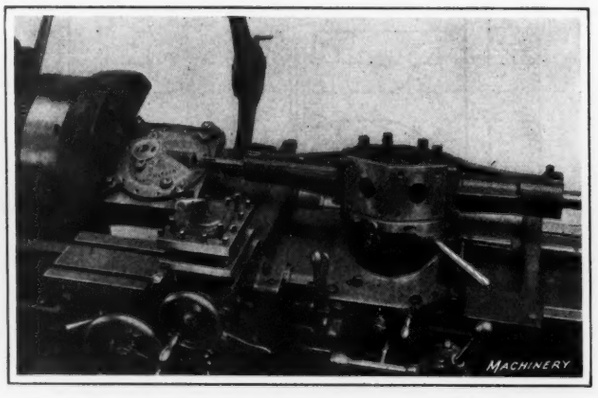


Fig. 26. Equipment for Third Operation on Steam Trap Cover

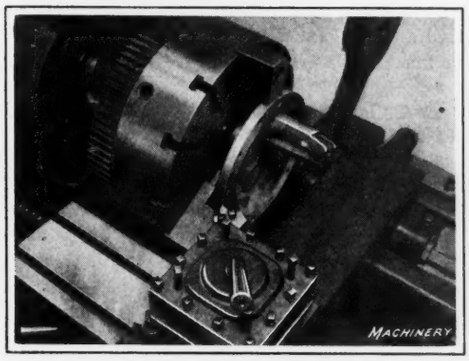


Fig. 27. Facing the Flange of a Steam Trap Cover

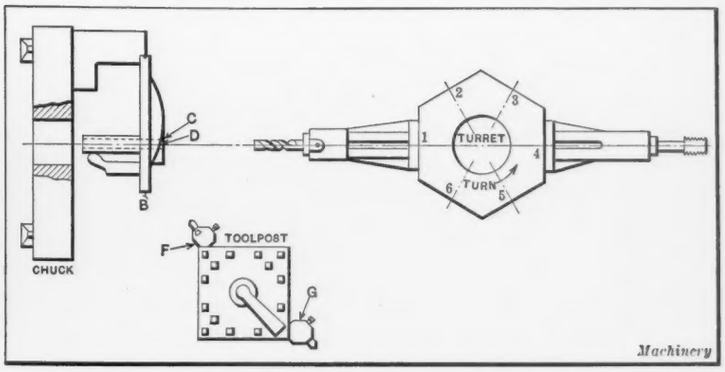


Fig. 28. Tooling Lay-out for Second Operation on Steam Trap Cover

STORAGE AND HANDLING OF OILS

All petroleum products, including lubricating oil, throw off an explosive vapor. Gasoline is more dangerous to handle than dynamite, as with it there is more likelihood of an explosion. With lubricating oils, however, the danger is chiefly caused from spontaneous combustion, where waste, sawdust, or shavings are used to absorb the oil spilled on the floors. It is a common mistake to neglect the accumulated refuse which in time bursts into flame. Paint oils, such as linseed oil and turpentine, should also be carefully handled. A piece of cotton waste saturated lightly with equal parts of linseed oil and turpentine will burn from spontaneous combustion in about three hours' time if left in a closed room.

Aside from the growing danger to life and property caused by carelessness in handling and storing oils, the increasing prices of all kinds of oil products should be given serious consideration. Much money is lost annually from deterioration of quality and from waste in handling oils. Over-heating of bearings can frequently be traced to deteriorated or contaminated oils. The trouble is usually traceable to poor oil-storage.

Modern storage equipment for handling liquids of this type is divided into two general types. For storing volatile liquids such as gasoline or naphtha, underground tanks should be used. They should be cylindrical in shape, and if made of galvanized steel, all seams and rivets should be carefully made and soldered. If heavy metal is required for the tank, all seams and rivets should be carefully calked. Storage tanks for all volatile liquids require special care in construction, and tanks that hold water or steam-pressure are usually unfit for storing volatile liquids.

Above-ground tanks for lubricating oils are usually made in rectangular shape, a good practice being to maintain a constant height and length and to vary the width according to the desired capacity. This arrangement permits the addition of other units to the system and does not destroy the uniformity of the battery of storage equipment. Rectangular tanks should, of course, be made with the same care as those of cylindrical design.

Specially designed pumps of either measuring or non-measuring type are connected to underground tanks or inserted in the top of rectangular tanks. Gear-driven meters may be included for the purpose of checking the consumption. As a means of preventing unauthorized usage and a precaution against theft, locks should be supplied on both tanks and pumps. Where a battery of individual tank units is used, a barrel track and barrel drainers may be used in connection with smll chain hoists. This facilitates handling the barrels and enables them to be drained completely into the tank, which results in a considerable saving of labor and time, and also prevents loss due to the barrels not being properly drained. An arrangement of this kind will result in the exclusion of dirt, dust, and sediment, and also eliminate the danger of fire. This method furnishes a means for determining the rate at which the oil is consumed.

"LIBERTY FUEL"

The United States Fuel Administration, having received many requests for information concerning aviation fuel called "Liberty fuel," has made public the results of various investigations concerning its composition, the available supply of ingredients, and its efficiency. Tests made in the aeronautic laboratories of the United States Army and placed at the disposal of the Fuel Administration resulted in information that the fuel was made up of "approximately 65 per cent of benzol; 25 to 30 per cent of kerosene; and the remainder of a small percentage of amyl acetate and probably naphthalene and alcohol, together with, perhaps, small quantities of dissolved solids, and other volatile liquids as yet undetermined."

In this analysis the available supply of the fuel must depend on the amount of benzol, its chief constituent, that is obtainable. Investigation in this direction showed that if the total production of benzol (3500 barrels a day) were so used, the total production of Liberty fuel would be about 2 per cent of the present output of gasoline, which is approximately 90,000,000 barrels a year. Benzol, however, has other uses, notably in grease extraction and as a solvent for rubber.

A gumming and corrosion test, also conducted in the aeronautic laboratories of the Army, showed no perceptible corrosion, but "a tremendous amount of gumming—0.4 per cent, accompanied by extensive fuming and a penetrating odor." The tendency of the gummy residue in the fuel would be to plug up carbureters. In the same Army laboratory test, crystallization was found to set in at 18 degrees F. and to be "practically complete" at 15 degrees F. Boiling started at 175 degrees F., as against an initial boiling point of not more than 140 degrees for engine gasoline, which was an indication that the latter possessed better starting qualities.

According to the Bureau of Standards, the results of tests in an aviation engine indicated that Liberty fuel, compared with gasoline fulfilling the specifications for aviation gasoline, will, when consuming 10 per cent greater weight of fuel per horsepower-hour, develop about 3 per cent greater horsepower. The spark-plug used in Liberty fuel showed a slightly greater carbon deposit than the plugs used in the run of export gasoline.

Information furnished the Fuel Administration by the Navy Department states that a flight of 40 minutes was made with the fuel, and that "no observations were made which show that the fuel would accomplish any other results than to operate the engine in a manner similar to the aviation fuel which had been used." Arrangements were made, the Navy Department reports, for sufficient quantities of the fuel to make full tests, but the fuel was not supplied. A letter from Benedict Crowell, Assistant Secretary of War, states: "The situation has not reached such a stage that this office feels that any definite announcement can be made, or that it can express a definite opinion as to the fuel's true merits."

SUGGESTED IMPROVEMENTS IN MACHINE TOOL DESIGN

By CHARLES A. TRASK

Belt speeds of most lathes, especially those employing cone drives are, in the writer's opinion, too slow. Now that many makers are building the headstocks of their lathes with the front and rear spindle bearings tied together by a web reaching from about the center line to the bed, there seems to be no reason why the diameter of the cone cannot be nearly as large as the full swing of the lathe. Well-known authorities agree that the most efficient belt speed is approximately 4500 feet per minute. As a belt running at this speed will burn the hand, it is obvious that a shifter would be required to change speeds on a cone-driven lathe if this belt speed were employed. Good belt shifters for use on cone drives are available, but whether or not a shifter is used, there is one change in the cone design which would greatly improve this type of lathe. This change consists in adding one step to the smaller end of the lathe cone so that this cone would have one more step than the countershaft cone.

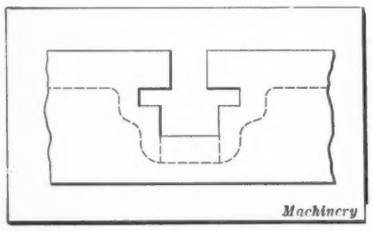


Fig. 1. Improved Form of T-slot for Drilling Machine Tables

It is not unusual to see work in a lathe running at about half the correct speed with the belt on the smallest step but one; this practice is followed because of the inconvenience of removing the belt from the smallest pulley when the work is completed. If there were an extra and smaller step on the lower cone, the operator could easily obtain sufficient slack to enable him to easily throw the belt on and off the largest step on the countershaft cone.

Now let us consider the speed of overhead belts. In circulars recently issued by ten well-known lathe builders, the specifications call for an average overhead belt speed of approximately 710 feet per minute. If the most efficient belt speed is approximately 4500 feet per minute, why should not the overhead belt speed be increased? In this connection, the writer cites the following instance in which 36-inch tight and loose pulleys were put on some lathe countershafts in place of 16-inch pulleys. Before this change was made, 6-inch belts were used at 1250 feet per minute. After installing the larger pulleys, only 3-inch belts were needed which ran at 2825 feet per minute. The former friction load on the hanger boxes was cut in two by this change, the 3-inch belts cost only half as much, and less power is now required.

Balancing Handwheels and Pulleys

Handwheels on tailstock and cross-slide screws should be carefully balanced, especially the former. Many a piece of work has been injured or spoiled by the tailstock screw backing up part of a turn due to lack of balance in the handwheel. Pulleys, gears, cones, etc., that revolve at any considerable speed should be balanced, and should not be put in operation until tests show them to be in perfect running balance. Recently two light drilling machines and two 16-inch lathes were purchased. The standing balance of all the cones on these machines was obtained by riveting a weight inside the largest step, which had been bored true with the holes, thus insuring reasonably accurate balance at this point before the weight was applied. In the case of the first drilling machine to be started, the running balance was very bad and threatened to tear the countershaft bracket off the column. The cone was removed and upon testing it was found to be in perfect static balance. The balance weight was removed and placed on the thin side of the cone about midway between the two ends. The cone was then replaced and the machine ran with but little vibration. The other machines were dealt with in the same way.

Tailstock Fastenings

Except for casting ratchet teeth in the beds of some types of large lathes, and providing a dog or a pawl on the under side of the tailstock which engages the ratchet teeth, little or no improvement in tailstock fastenings has been made in recent years. As a rule, bolts with hexagon nuts, many of which are located in more or less inaccessible positions, are still used to fasten the tailstock. A lathe manufacturer brought out a tailstock about thirty years ago that was held down by a 1-inch stud which screwed into the bottom of the tailstock base. Keyed to this stud was an eccentric gear, which was very eccentric. Under the rear end of the spindle, a handle was keyed to a short vertical shaft on the lower end of which was keyed another eccentric gear which mated with the gear on the stud. In the writer's opinion, this arrangement was the nearest approach to the ideal which he has ever seen. The lever or handle was always in place. One movement locked the tailstock securely, as the leverage through the eccentric gears was 2 or 3 to 1 in the operator's favor at the tightening position of the lever.

T-slots in the drilling machine table are a source of trouble to every machinist. Many of these troubles can be eliminated by providing drill tables with T-slots of the shape indicated in Fig. 1. In this form of slot, a common bolt and two common washers can be used so that it is unnecessary for the blacksmith to make up a lot of bolts with special heads. There should be one or two cored holes passing entirely through the bottom of the bolt slot as shown by the vertical dotted lines. These holes will let the chips fall through when the bolts are slid in place. Machinists will appreciate this feature, as they usually find it necessary to employ a slot scraper before attempting to insert the bolts in their required positions.

Counterweights for Drilling Machine Spindles

Another element of importance in drilling machine design which deserves considerable attention is the method of counterbalancing the spindle. It should be remembered that a drill chuck or tapping device is usually attached to the lower end of the spindle—therefore the counterweight should weigh a little more than the spindle and its sleeve instead of a little less as is the usual case. Counterweight chains are frequently too light, their size and wearing qualities being inadequate to meet requirements. These chains frequently break and the man in charge of the drilling department is all too often required to take out the foundation bolts and lay the drill on the floor, to repair broken chains.

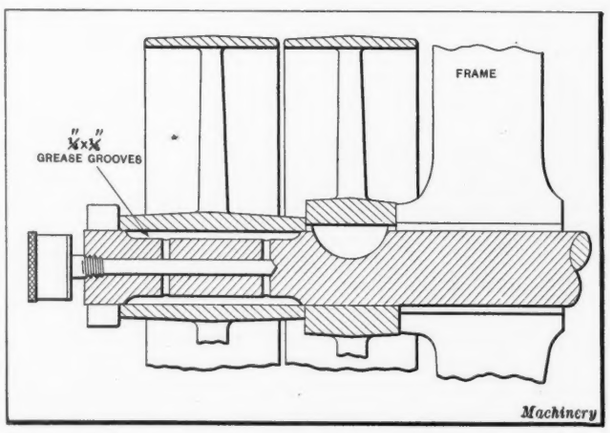


Fig. 2. Method of lubricating Loose Pulley on Drilling Machines

The writer has noted that with very few exceptions upright drilling machines have their tight and loose pulleys

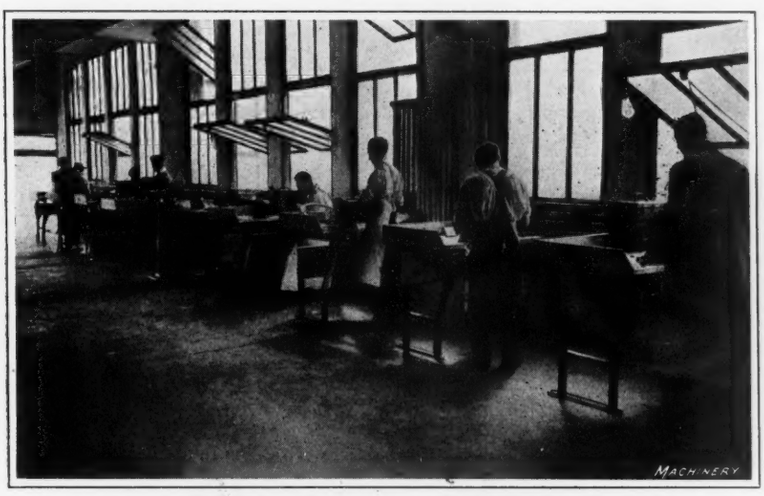
outside the main frame bearing, and in nearly every case, the loose pulley is next to the bearing. This throws the strain from the belt pull, when the machine is running, farther away from the shaft bearing, thus placing a considerably greater strain on this bearing than if the loose pulley were on the outside. To change this arrangement so as to allow the tight pulley to be located next to the bearing, would, of course, necessitate the use of a set-collar to retain the loose pulley in position. This would add very little to the expense, however, and the writer sees no reason why this more logical arrangement should not be adopted.

Then again, most drilling machines should be provided with more efficient means of oiling the loose pulley. An ordinary oil-hole through the pulley hub is not sufficient, and trouble will develop if no other means of lubrication is provided. The writer has in mind an instance in which a machine was used for work that required a reasonably tight belt; in two years the loose pulley and shaft were removed six times. Each time the shaft and pulley were removed a new bushing had to be inserted in the pulley and the old shaft replaced by a new one. Finally a shaft was made as shown in Fig. 2. This shaft has been in operation for three years, and it seems to be in perfect condition at the present time.

* * *

INDIVIDUAL BENCHES FOR TOOLMAKERS

The manner in which toolmakers' benches are installed in the new factory of the Twin-O-Matic Machine & Tool Co., Brooklyn, N. Y., is shown in the accompanying illustration. These benches are about 4½ feet long by 3 feet wide, are spaced about 4 feet apart, and are located at right angles to the windows. It is claimed that this method of installation has a number of advantages over the usual long continuous type of bench which is set parallel to the windows. The men interfere less with each other and thus both the production and the accuracy of the work are increased. The comfort of working for each man is also increased. He has all his tools on a bench all to himself, he can arrange his work and his equipment to suit himself without fear of encroaching upon the space required by his fellow-workers, and he feels altogether more free to carry on his work to the best advantage to himself and the job in hand. He also has better light, as he does not face the window, but receives illumination from the side, which for most classes of work will be found more advantageous. The arrangement has been found satisfactory in all respects.

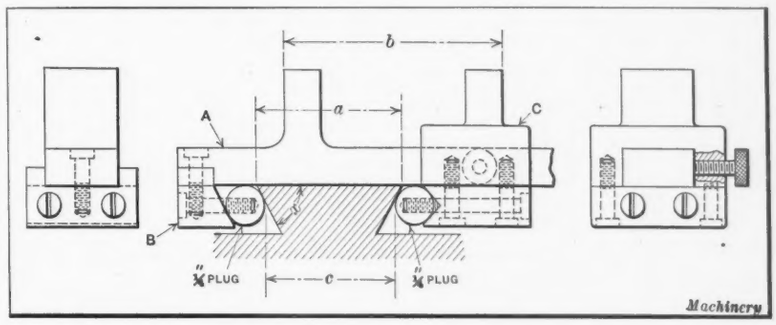


View of Toolmaking Department, showing Individual Benches

GAGE FOR MEASURING DOVETAIL TONGUES

By JOHN T. CLARK

The illustration shows a gage designed for measuring dovetail tongues. It consists essentially of a beam *A*, a stationary block *B*, and a sliding block *C*. The block *B* is secured to the end of beam *A* by machine screws, while block *C* may be moved along the beam in order to measure any tongue within the capacity of the gage. A 1/4-inch measuring plug is secured to each block, which bears against the angular surface of the tongue when a measurement is being taken. A measuring point is provided on both the beam and the sliding block to permit a micrometer reading of the dimension *b*. The measuring points were located so that dimension *b* would equal dimension *a* + 0.500 inch when angle *x* was equal to 60 degrees, so that, if on a 60-degree tongue dimension *b* measured 3.500 inches, dimension *a* would equal 3.500 — 0.500 = 3 inches. Locating the measuring points in this manner, permits the plugs to come close together so that narrow tongues may be measured.



Method of using Dovetail Tongue Gage

It is obvious that subtracting 0.500 inch from dimension *b* will give dimension *a* only when angle *x* equals 60 degrees. If dimension *a* is retained and angle *x* decreased, dimensions *c* and *b* will also decrease. Thus, in calculating dimension *a* it is necessary to add a certain quantity to dimension *b* before subtracting 0.500 inch, when angle *x* is less than 60 degrees. When angle *x* is greater than 60 degrees it is necessary to subtract a certain quantity from dimension *b* before subtracting 0.500 inch. The constants which must be subtracted from dimension *b* when measuring tongues having various angles are given in the accompanying table:

CONSTANTS WHICH MUST BE DEDUCTED FROM DIMENSION b TO FIND DIMENSION a

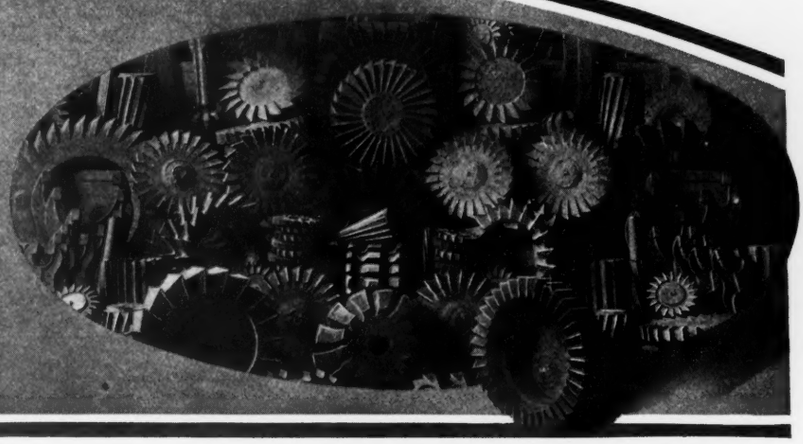
Angle x, Degrees	Amount to be Deducted for Various Angles, Inches
60	0.500
55	0.500 — 0.0142
50	0.500 — 0.0276
45	0.500 — 0.0406
40	0.500 — 0.0534
35	0.500 — 0.0654
30	0.500 — 0.0774

The following problem illustrates the use of the table: On a dovetail tongue where angle *x* is 45 degrees and dimension *b* measures 3.959 inches, dimension *a* would equal 3.959 — (0.500 — 0.0406) = 3.5 inches.

* * *

In a rigid airship structure, it is said that there are 20,000 different parts, not including the machinery, and, in addition, 2,000,000 rivets. The total length of the structure material is 20 miles, and the length of wire, 60 miles.

Chrobaltic Cast Milling Cutters



Methods Used in Casting Milling Cutters from a Chromium-Cobalt Alloy Steel

By EDWARD K. HAMMOND

DURING the period of intense industrial activity which existed in Great Britain from the outbreak of war in 1914 until the armistice was signed, difficulty was experienced in obtaining the necessary supply of high-speed steel milling cutters and similar tools. The inadequate supply of tungsten for use in making high-speed steel was mainly responsible for this tool shortage. Obviously, the situation demanded immediate action, and a partial solution of the problem was finally worked out by Darwin & Milner, Ltd., of Sheffield, who developed an alloy of chromium and cobalt which possesses the necessary physical and thermal properties to enable it to serve as a substitute for tungsten high-speed steel, in addition to which the metal may be cast to shape. The castings have a remarkable degree of strength and density of structure, and when properly made are free from blow-holes. Owing to the fact that castings of high quality could be made from this alloy, it was found possible to cast milling cutters and other multiple-edged tools to the desired shape and size, so that very little subsequent machine work was needed to convert the castings into finished tools. This was the means of saving a great deal of labor and expense in toolmaking. In addition to the application of this chromium-cobalt alloy for making cutting tools, it is well suited for making blanking, punching, and drawing dies, and various kinds of gages, as the alloy possesses a high degree of resistance to abrasion.

How the Process was Developed

While this method of toolmaking was developed as a war-time measure, its extensive application was considerably retarded by the restrictions placed upon all classes of industry that did not have a direct bearing upon the production of military supplies. But the economies made possible through casting tools to a shape closely approximating the desired form, instead of requiring high-priced mechanics to spend long periods of time in machining them from solid blanks, represents such a signal advantage, that this method of toolmaking is now being developed on a commercial basis by the Chrobaltic Tool Co., which is a subsidiary of the Rich Tool Co., Railway Exchange Bldg., Chicago, Ill. This firm

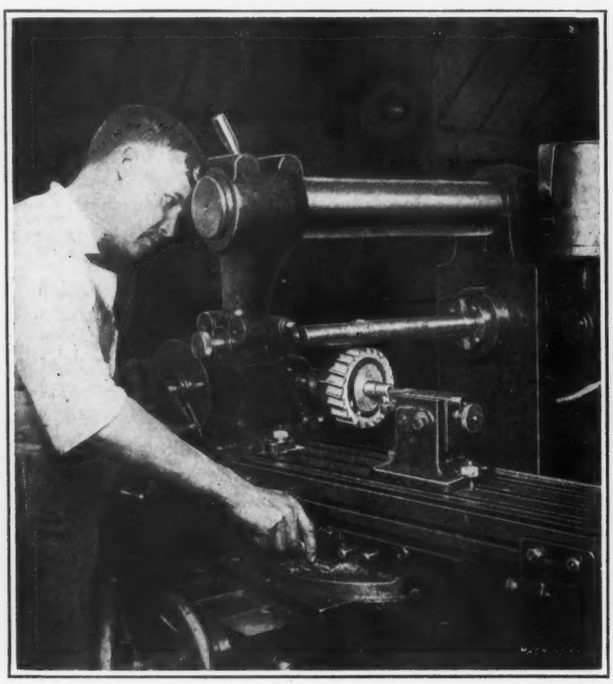


Fig. 1. Machining the Teeth in an Aluminum Milling Cutter Pattern

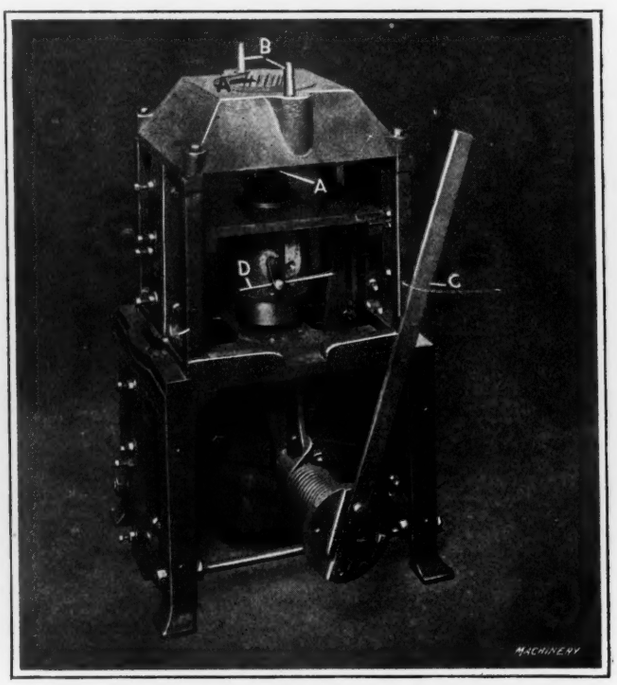


Fig. 2. Stripping Plate Machine making Plain Milling Cutter Molds

Fig. 3. Drying the Molds with a Torch Flame before They are closed

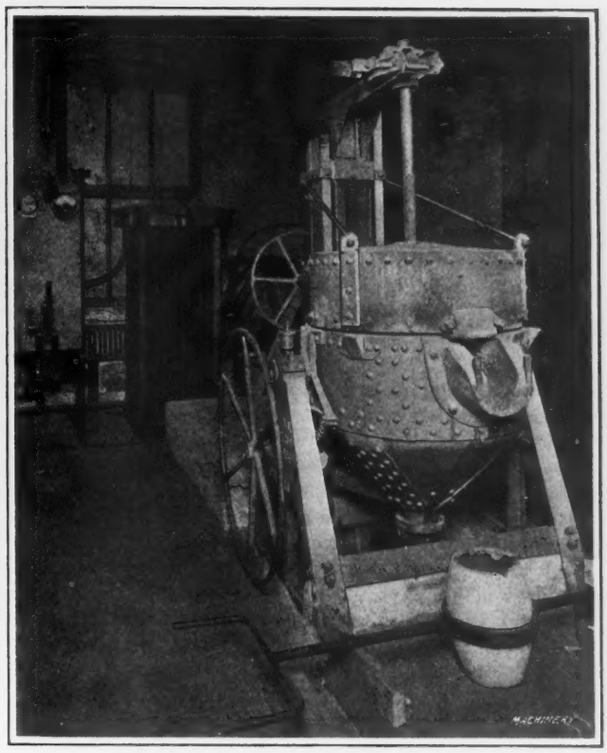


Fig. 4. Electric Furnace in which Chrobaltic Alloy is melted

is operating under a license to use the Darwin & Milner patent in the United States.

The following article explains how cast tools are made and gives information relating to the way that they stand up under actual conditions of service. Before entering upon this discussion however, it may be of interest to make mention of one or two other advantages claimed for cast tools.

Economies Resulting From Casting Milling Cutters and Other Tools

During the war an inadequate supply of tungsten was responsible for the development of the alloy from which chrobaltic tools are made, but under normal conditions of industry there is an adequate supply of this constituent of high-speed tool steel. Consequently, if cast milling cutters and other tools are to be sold in successful competition with high-speed tools made by the usual methods of manufacture, they must be of equal quality and have some advantage which will lead buyers to change over from tools made by an old and established method which is known to be satisfactory. In the case of cast tools, this advantage is stated to be a greater degree of economy, both in conducting the process of manufacture and in utilizing the scrap metal after the tools are worn out. In one case, in making milling cutters of the same size from high-speed steel and chrobaltic alloy, respectively, the time required to make the cast tools was only 27 per cent of that required to complete high-speed steel cutters by the usual tool-room method. Such

Fig. 5. A Corner of the Foundry, showing One Row of Molds closed and Ready to be Poured, and a Second Row Open, that have just been dried with a Torch Flame

a saving of labor is in itself significant, but does not represent the complete economy which is effected by this method of manufacture.

When a cutter is machined from a solid blank of high-speed steel, there is obviously a large amount of wastage resulting from the removal of metal from the bore, from the spaces between the teeth and from clearance spaces which are machined at each end of the cutter between the hub and teeth. With a cast cutter practically all of this waste of expensive steel is eliminated. In the case of the two cutters to which reference has been made, five pounds of chrobaltic alloy made a cutter of the same size as that which was machined from a high-speed steel blank that had an original weight of ten pounds, the cost per pound of these two materials being the same. Furthermore, when the cast cutter is worn out, the residual metal can be returned to the tool manufacturer, melted up and recast into tools of exactly as good quality as those produced from material that has not previously been used in the machine shop. With high-speed steel, while the scrap metal is valuable, it cannot be used again before subjecting the steel to a special metallurgical treatment in connection with the melting.

Cast tools may either be completely finished and supplied to the customer hardened and ground ready for use, or castings will be delivered annealed, ready to be machined to exactly the required size, after which they will be hardened and ground in the usual way. It is important to note that tools made of this material may be annealed and rehardened without detriment to the physical properties of the metal. Also they show very little tendency to rust and possess a high resistance against heat, which is important both from the standpoint of allowing the tools to be operated at high cutting speeds and heavy feeds, and to provide for hardening delicate forms of milling cutters and other tools without impairing their quality. The metal does not distort appreciably during the process of heat-treating.

From the preceding description it will be clear that tools made by the process of manufacture employed by the Chrobaltic Tool Co. are cast from molten metal. Such being the case it is obvious that patterns must be provided for use in making the molds. Where a considerable number of tools of a given type and size are to be cast, the usual practice is to make a metal pattern for use in the foundry; and after the blank for such a pattern has been turned up on the lathe, most of the subsequent work can be handled on a universal milling machine, as illustrated in Fig. 1. In machining the pattern, an allowance must be made for the shrinkage which occurs when molten steel solidifies; and it is also necessary to provide from one-sixteenth to one-eighth inch of metal on all surfaces that are to be subsequently machined, so that there is assurance that the casting will "clean up" properly. In some cases it is found possible to use a finished steel tool as a pattern, where only a few castings are to be made.

Application of "Multiple-purpose" Patterns

Another economy in regard to the use of patterns consists of the employment of a single pattern for making a number of tools of various widths. For instance, consider the case of plain milling cutters, of which a variety of face widths are likely to be ordered in the same diameter. The expense of making a series of patterns to cover such requirements would represent quite a heavy overhead burden; and there would be an additional item of expense in storing these patterns and finding the proper one when it was required for use. Such difficulty is completely overcome by making a single pattern of the maximum face width, and using this pattern on a stripping plate machine built by the Cleveland Osborn Mfg. Co., Inc., of Cleveland, Ohio. A machine of this type is shown in operation in Fig. 2, a small portion of the plain milling cutter pattern *A* being shown projecting both above and below the ramming plate at the top of the machine. In using a stripping plate machine of this type, the cope of the mold is dropped into place over guide pins *B* and with the pattern raised to its maximum height above the ramming plate, the molder proceeds to pack the sand into place in the cope of the mold. He then swings lever *C* to provide for drawing the pattern down through the ramming plate. On this plate there is a guide which exactly fits the pattern, and in the case of a spiral tooth plain milling cutter the withdrawal of the pattern from the mold consists of a combined downward and rotary movement. Were it not for this combination of motions, the pattern could not be withdrawn from the mold without destroying it. Mention has already been made of the fact that a single pattern can often be used for making a number of castings of different face widths. This result is accomplished by means of an adjustable pin *D* which may be placed in various positions in the stripping plate machine to provide for raising the pattern to different distances above the top of the ramming plate. Before the molds are finally closed, after the cope and drag have been separated to remove the pattern, the sand is thoroughly dried by applying heat with a torch flame, as shown in Fig. 3. Constituents of the chrobaltic alloy are melted in an electric furnace shown in Fig. 4, as it is found that there are numerous advantageous features in such an equipment, among which may be mentioned accurate regulation of the temperature that assures uniformity of the metal.

Aside from the making of patterns and the use of a stripping plate machine, there is nothing of exceptional interest in connection with the foundry practice employed for making these chrobaltic tool castings. The constitu-

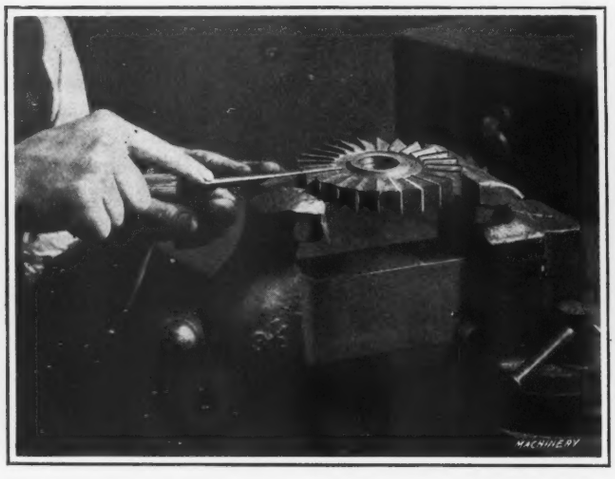


Fig. 6. Removing Slight Surface Defects from Casting with a File

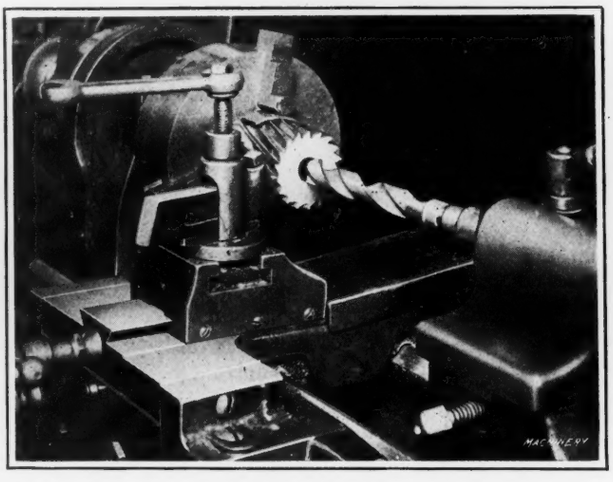


Fig. 7. Boring the Arbor Hole and facing the End of the Cutter

ents of the alloy are carefully weighed out and charges are made up with the same degree of care that is exercised by a druggist in compounding a prescription. The molten metal is then placed in crucibles which have been preheated in an electric furnace. Fig. 5 shows the men engaged in pouring one line of molds, and another line is shown with the molds open. Before leaving the discussion of foundry work, it may be of interest to note that all molds are made with a horn gate that provides for delivering the molten metal from the bottom of the mold. Directly over the opening in the mold, a space is provided for a riser or feeder. The pouring is continued until the molten metal rises up in this feeder, and there is then a sufficient volume available so that adequate provision is made for taking up the shrinkage which occurs when the alloy solidifies.

Composition of Suitable Molding Sand for Casting Tools

It is of importance for the molding sand to be of the right composition in order to produce good clean castings. Chrobaltic alloy castings of good quality should appear more like forgings than castings, as the metal is usually close-grained and dense.

After the castings have been poured, they are allowed to stand in the molds over night in order that the steel may

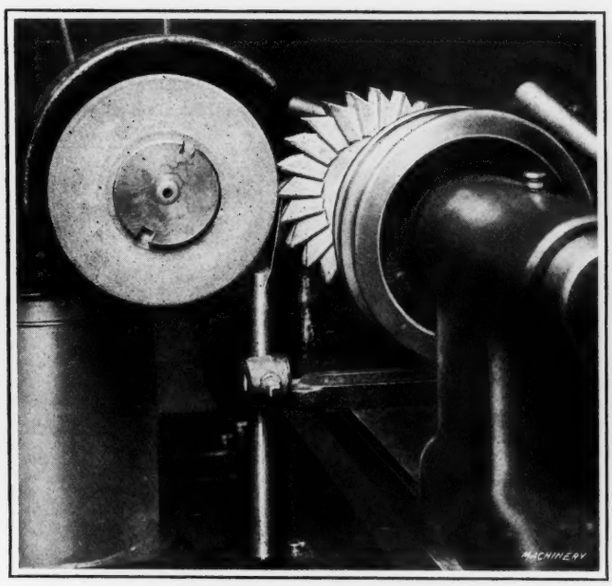


Fig. 8. Sharpening Side-tooth Milling Cutter Ready for Use

Fig. 9. Stamping Chrobaltic Imprint and Size on a Cutter

be partially annealed. The next morning the molds are broken open and the castings are annealed for eight or ten hours, the exact time depending upon the shape and size of the castings. The annealing furnace is kept at a temperature of 1450 degrees F. and the castings are left in the furnace to cool. This annealing operation gives the tools a scleroscope hardness of 38 degrees, and they can then be machined at a cutting speed of 25 to 30 feet per minute. The equipment used for annealing consists of a No. 353 gas furnace, made by the Standard Fuel Appliance Co., Detroit, Mich. After the annealing operation has been completed, the castings are taken to a Pangborn sand-blasting machine which removes all scale and particles of other foreign material which are clinging to them. The next step is to go over all surfaces with a file, as shown in Fig. 6, to remove fins and any particles of foreign material which may have escaped removal in sand-blasting, after which the cutters are set up in a lathe or chucking machine to have the hole bored and the hub faced at each end, this operation being shown in Fig. 7. The work is then transferred to a Wilmarth & Morman universal tool and cutter grinding machine to provide for grinding the outside diameter, as shown in Fig. 8, and the spaces between adjacent teeth. After being ground, the next step in the process of manufacture is to mark the tools with a number and the maker's name, this being done with steel stamps, as shown in Fig. 9, after which they are set up on a Mitts & Merrill keyseater to provide for cutting the keyway.

Method of Hardening Chrobaltic Alloy

In order to obtain the most satisfactory results from chrobaltic alloy tools, great care must be taken in conducting the process of heat-treatment, which is of special nature to meet the requirements of this metal. Tools to be hardened are placed in a Stewart furnace in which their temperature is raised to 1832 degrees F., after which they are allowed to remain in the furnace for a sufficient length of time to become thoroughly "soaked" with heat. The temperature is then allowed to drop from 25 to 50 degrees F., while the work remains in the furnace, and then the cutters are removed and allowed to cool in the air until they no longer show a red color when held in a position where there is no direct exposure to light. When this point has been reached, the tools are quenched in oil and allowed to remain in the bath until quite cool. The oil used for this purpose should have a flash point of 450 degrees F. The way in which the temper is drawn will depend somewhat upon the nature of the service required of the finished tool, but in any case the temperature will be raised to some point between 800 and 900 degrees F.

Finish-grinding the Tools Ready for Use

After the heat-treatment has been completed, the tools are taken back to the Wilmarth & Morman universal tool and cutter grinder, for clearance grinding the cutting edges, making the tool ready for use. From the preceding description it will be apparent that the cast tools are not machined on the sides and other surfaces where a finish might add slightly to their appearance, but in so doing would also add an item to production cost without increasing the productive capacity of the tool. The tools are now ready to be packed for shipment to the user. It will be apparent that the preceding description applies where tools are completely finished ready for use; but mention was made of the fact that some customers prefer to buy annealed castings and machine them in their own tool-rooms. Where castings are produced for shipment to such consignees, the method of manufacture is exactly the same as that which has been described except that the work is carried through the annealing process and then shipped to the user's shop, where all subsequent work is done.

Results Obtained in Using Chrobaltic Cutters

In showing the results obtained with milling cutters made of chrobaltic alloy, it may be mentioned that there is practically no difference between the service obtained from these tools and cutters made of high-speed steel, where ordinary temperatures and other conditions of service are encountered. It is claimed, however, that where there is considerable abrasive action of the chips on the lip of the tool, as in the machining of phosphor-bronze, the chrobaltic cast cutter will give a substantially greater amount of service under given operating conditions.

The following examples of conditions under which these tools have been used will give a good idea of the amount of work of which they are capable. A milling cutter 3 inches in diameter by ⅜ inch face width, taking a cut ½ inch deep in a steel forging, was driven at 42 revolutions per minute with constantly increasing rates of feed. The feed was started at 1⅛ inches per minute, and was increased to 4¾ inches per minute, under which conditions the cutter operated satisfactorily. The feed was then increased to 6⅛ inches per minute, and under these severe conditions the cutter broke after making a cut 2 inches in length. In another case, a cutter 7 inches in diameter by ⅝ inch face width was used in conducting a test on a steel billet. The cutter was driven at 29 revolutions per minute, and in one case the feed was 1¾ inches per minute, with a depth of cut of ½ inch; while in the second case, the feed was 1⅛ inch, with a depth of cut of 1 inch. In both of these cases, the cutter operated satisfactorily and showed no signs of wear.

Until the invention of chrobaltic alloy, the theory prevailed that rolling, pressing, or forging was absolutely necessary in the production of steel for use in making milling cutters and similar tools, in order to give it the required density and toughness; but that equivalent physical properties to those obtained by forging are present in tools cast from chrobaltic alloy is attested by the fact that the tools are able to give entirely satisfactory service under severe conditions of operation.

As another example of results obtained in actual practice may be mentioned the milling of cast-iron gibs, 2¼ inches wide, from which from ⅛ to ⅛ inch of material is removed. The feed rate is approximately 30 inches per minute, and the table feeds in both directions alternately; that is, the first piece will be fed against the direction of the rotation of the cutter, and the second piece with the direction of rotation. Under these conditions, the chrobaltic alloy cutter stood up for a complete day's output, and was apparently sharp at the end of the test.

A cast tire forming or scraping tool of chrobaltic alloy averaged twelve pairs of tires per grind on 66- and 72-inch driving wheels, the work being done on a No. 90 Putnam wheel lathe. Most mechanics, as well as most metallurgists, agree that worn locomotive tires by virtue of the metal itself, and the subsequent cold-rolling action in service, are more difficult to turn than almost any other regular operation, and that this is one of the hardest jobs to perform.

* * *

In the committee meetings at the International Trade Conference at Atlantic City, it was stated by French representatives that the only real needs of metals by France during the coming year will be confined to about 100,000 tons of ship plates, and about 90,000 tons of copper in bars, ingots and electrolytic copper. This modest demand is due to the extensive additions to French metal resources in the mines of Alsace-Lorraine. France will not only be able to meet all her domestic steel requirements, but also to produce an exportable surplus of about 2,000,000 tons. Copper needs will be met largely from the salvage of the waste of the battlefields, and aluminum will be utilized as a substitute wherever possible. The French coal deficit will be about 22,000,000 tons, and the French delegates are asking that as much of this come from the United States as can be spared.

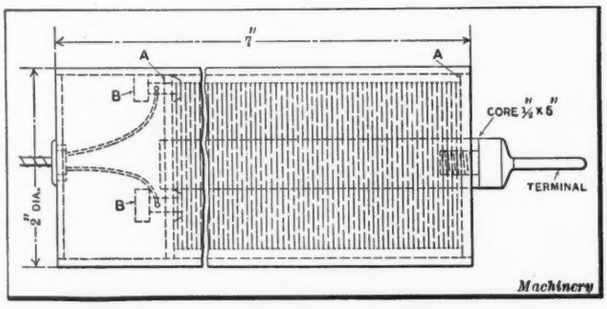
ELECTROMAGNET FOR SHOP HOSPITALS

By H. L. CAMPBELL

In metal-working plants, accidents are often caused by flying particles of steel which penetrate the flesh of the workmen. These chips have sharp, angular edges, and in injuries of this kind blood vessels are often severed. In order to prevent infection and irritation, it is necessary to remove the foreign particle immediately and to thoroughly disinfect the surfaces of the wound. The common practice is to enlarge the wound so that forceps may be used in removing the piece of metal, but if the wound bleeds freely this method is difficult. Under all conditions the practice of probing and digging for the metal particle is very painful.

As an aid in removing fragments of metal from punctured wounds, an electromagnet has been found of advantage. A pointed terminal made of refined iron is attached to the core of a hand magnet. When the exact location of the foreign particle has been determined, the terminal is sterilized and inserted in the wound. When the electric circuit is closed, the particle is attracted and may then be readily withdrawn by the magnet. After the fragment of metal has been removed, it is important that the internal surface of the puncture be thoroughly disinfected. Injuries to the eye should always be attended by a specialist, but in many cases the magnet may be used in removing minute particles of metal from the eye.

The electromagnet which is here illustrated, is constructed as follows: A wrought-iron core 1/2 inch in diameter



Electromagnet used to remove Particles of Metal from Wounds

and 6 inches long, is provided, in one end of which a 1/4-inch hole is tapped, 3/8 inch deep. On this core between two fiber disks *A*, one pound of No. 27 cotton-insulated copper wire is wound. A vulcanized fiber cylinder, 2 inches in diameter and 7 inches long, is used to enclose the coil. The cylinder is perforated with 1/8-inch holes, spaced 1 inch apart, to allow ventilation of the coil. It will be noticed that two binding posts *B* are provided for attaching the connecting wires. A third fiber disk covers the connecting end of the cylinder, so that the coil is completely enclosed. A number of threaded terminals should be provided, permitting the used ones to be readily removed, sterilized, and kept in readiness for further use as required. This instrument is of convenient size and has a strong magnetic attraction. It may be made with little expense at any electrical shop. A direct current of 110 volts is used.

* * *

Belting experts often find fault with the low speeds at which belts are being run, these low speeds being the cause of inefficiency and waste of power. Whenever possible, belts for transmitting power should be run at from 4000 to 4500 feet per minute, while they are frequently run at only 1000 feet per minute. As a result, wide belts are being used when a narrower belt, running at a high speed, would prove both cheaper and better. In addition, bearing pressures would be lessened and the friction and accompanying wear and power consumption reduced; thus, the expense for belts, fuel, and oil would be decreased to a considerable extent.

LETTERS ON PRACTICAL SUBJECTS

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UNIVERSAL SINE BAR

In reference to the article "Universal Sine Bar for the Toolmaker" which appeared in the August number of MACHINERY on page 1159, the writer fails to see how the gage shown in Figs. 2 and 3 can be clamped to the angle-plate and still rest upon the sine bar when grinding the 32

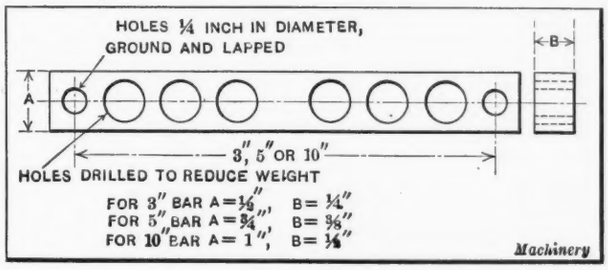


Fig. 1. Sine Bar for Toolmakers

degree 17 minute angle. According to the dimensions given in Fig. 1, it would seem that the sine bar proper is 1¼ inches from the angle-plate, as the base projects that distance from the sine bar.

The writer has used a sine bar like the one shown in the accompanying illustration Fig. 1 for some time and has found it useful in checking and working up gages of all kinds. A 3- or 5-inch sine bar can be used for grinding small profile gages, etc., but whenever possible it is advisable to use a 10-inch sine bar because the longer the bar, the more accurate will be the angle.

The sine bar shown in Fig. 1 was made of machine steel, carburized and hardened, then ground and lapped on its four sides. The two ¼-inch holes at the ends were then ground and lapped to the proper distance apart and fitted or checked with two ¼-inch standard plug gages. In order to save time in setting this sine bar it is a good plan to square up an angle-plate, as shown in Fig. 2, and bore a series of ⅜-inch holes at required distances from the base of the plate. The dimensions from the base to each hole should be marked in plain figures. To prevent undue wear, hardened and ground bushings should be pressed into these holes. The holes in these bushings should be lapped to fit the ¼-inch plug used in connection with the sine bar. To mount the

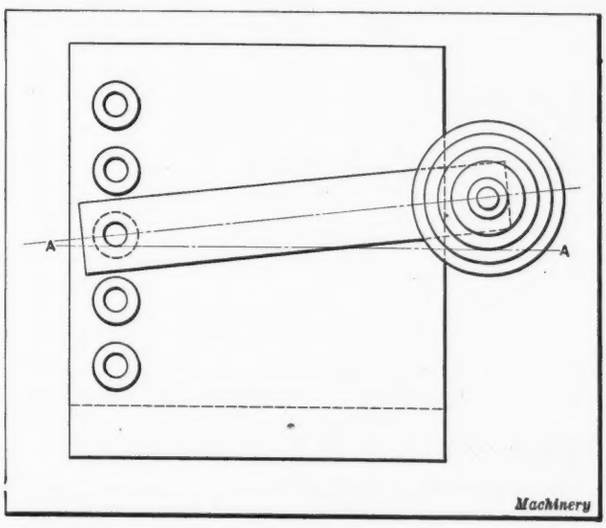


Fig. 2. Special Angle-plate used in Connection with Sine Bar and Plug shown in Fig. 3, for checking Angles on Standard Taper Gages

sine bar on the angle-plate the plug is first pushed into the sine bar and then into one of the bushings in the angle-plate, thereby forming a swivel or pivot. As the height of the stationary end is known, it is an easy matter to set the sine bar to the required angle by adjusting the movable end to the correct height, using a height gage or precision gage-blocks for this purpose. If a 10-inch sine bar is used, a height gage is sufficiently accurate for all practical purposes.

In Fig. 3 is shown a plug which can be used in connection with the sine bar for checking the angles on standard taper gages. The steps are ground to the required size, end *A* being ground to an accurate fit in the ¼-inch hole in the movable end of the sine bar. When checking tapers it is only necessary to insert the ¼-inch plug through the sine bar and the angle-plate as shown in Fig. 2, then insert the stepped plug in the movable end of the sine bar and use an indicator attached to a height gage or surface gage. The indicator should be set to zero on the plug at the stationary end and the movable end brought up until the indicator registers zero on the required step which is determined by the number of the taper being checked. It will be found that this stepped plug is a great time-saver.

Again referring to the sine bar in the article previously referred to, the writer is of the opinion that it possesses several features which would prevent it from being entirely satisfactory for tool-room use. First the screw at the pivot is too small to hold the sine bar in place properly after it

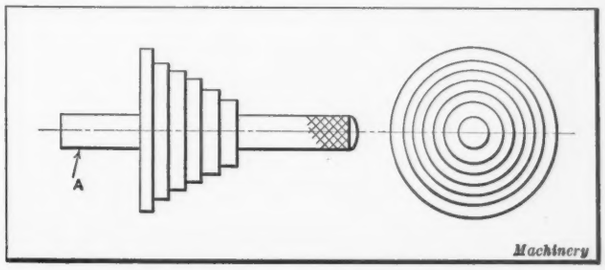


Fig. 3. Plug designed for Use in checking Standard Tapers with Sine Bar and Angle-plate shown in Figs. 1 and 2, respectively

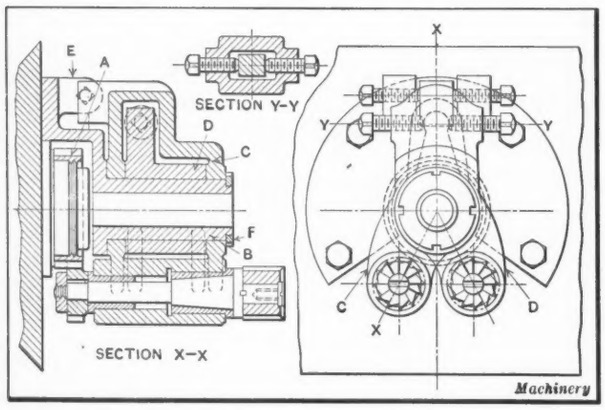
has been set. Then it seems as though the adjustable button on the movable end would be a source of constant trouble when setting the sine bar to any required angle. A certain amount of tapping would be necessary to adjust the button the proper distance from the base, and as a result the position of the movable button on the sine bar would frequently become changed a sufficient amount to render the setting inaccurate. The time saved by this type of sine bar might be offset by that lost in resetting the button if it were not handled with extreme care. Another objection is that it could not be conveniently used for grinding profile gages because the base prevents it from being brought up flush with the face of a regular angle-plate.

Detroit, Mich. WILLIAM BLAKESLEY

MILLING ATTACHMENT

The double-spindle milling attachment illustrated herewith may be used on a single-spindle machine for performing certain types of work which ordinarily require the use of a double-spindle machine. For squaring the ends of shafts having a shoulder, it has been found especially valuable, since performing this work by straddle-milling is impracticable on account of the cutters cutting into the shoulder.

Two cutters, which are of the shell end-mill type, are



Double-spindle milling Attachment for squaring Shafts

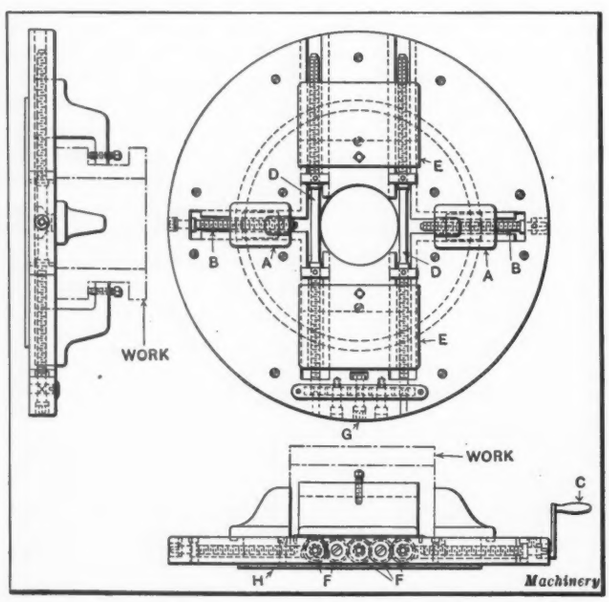
driven through gears on the opposite ends of the cutter-shafts. These gears mesh with the driver *A*, which is screwed to the milling machine spindle and is always in mesh with the cutter-spindle gears no matter what the adjustment of the cutters may be. The central bearing *B* has a flange which is attached by machine screws to the column of the machine so that the bearing proper is concentric with the spindle. There are two cutter-holders, both of which are free to swing on the bearing *B*, thus permitting a considerable "spread" for the cutters. The outside cutter-holder *C* has a tongue at the top by means of which the position of the cutter may be set as desired, by adjusting the binder screws which are carried in lugs *E*. The inside cutter-holder *D* has an adjusting finger projecting within a housing in the holder *C*—the method of adjusting the cutter being similar to that employed for the outside cutter. The attachment is secured in position after being assembled by means of nut *F*, which is threaded to the end of bearing *B*, as shown.

Valentigney, France — A. CLERC

BORING MILL CHUCK

The chuck shown in the illustration was designed for holding locomotive driving-wheel boxes while being machined on a 54-inch boring mill. The dot-and-dash lines indicate a box clamped in the chuck. The jaws are machined to fit slots milled in the chuck body. Jaws *A* are operated by means of screws *B* when they are revolved by turning handle *C*, the jaws being tapped underneath to suit the screws. The screws *D* which operate jaws *E* are revolved through the medium of gears *F* when the handle *C* is used to turn the short-headed shaft *G*. These jaws are tapped to suit screws *D* which have right- and left-hand threads at opposite ends to permit both jaws to be opened or closed simultaneously. A slot is milled through the body of the chuck to provide for the assembly of gears *F* which are covered by a piece of thin wrought iron. The ring *H* on the bottom of the chuck body seats in a corresponding recess on the boring mill table, so that the chuck may thus be readily located concentric with the machine. The fixture is secured to the machine table by fillister-head machine screws. This type of chuck could be adapted for holding various classes of work if the jaws were designed to suit the particular work to be held.

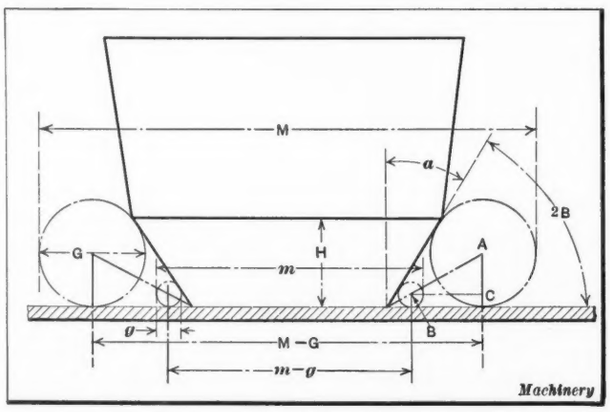
NORMAN MCCLEOD



Chuck used for holding Locomotive Driving-wheel Boxes

MEASURING THE ANGLES OF TAPERED PLUGS WITH TWO SIZES OF WIRES

The angle of a tapered plug may be measured by taking two micrometer readings over two pairs of wires of different sizes. This method is useful in the checking of the angle on the short taper of a small chamber check. When the distance *H* in the accompanying diagram is very short this method of measurement may be used to advantage. Referring to the diagram, *G* and *g* equal the diameters of the maximum and minimum wires, and *M* and *m* the micrometer readings over the maximum and minimum wires, respectively. Then



Use of Two Sizes of Wires for measuring Tapered Plugs

$M - G$ = distance between centers of maximum wires;

$m - g$ = distance between centers of minimum wires.

In the triangle *ABC*,

$$\tan B = \frac{AC}{BC} \qquad (1)$$

But

$$AC = \frac{G - g}{2}$$

and

$$BC = \frac{(M - G) - (m - g)}{2} = \frac{(M - m) - (G - g)}{2}$$

Therefore, substituting in Equation (1):

$$\tan B = \frac{\frac{G - g}{2}}{\frac{(M - m) - (G - g)}{2}} = \frac{G - g}{(M - m) - (G - g)}$$

$$a = 90 \text{ degrees} - 2B$$

and

$$2 \tan a = \text{the taper per inch}$$

Richmond College, Va. — V. E. AYRE

BORING RECESS AT BOTTOM OF HOLE

It is often necessary to form a recess at the bottom of a drilled hole in order to provide clearance for cutting threads or keyways. When a piece is so designed that such clearance must be provided at the bottoms of several holes it

usually requires considerable time to set the piece up on the lathe faceplate in the correct positions for boring the recesses, especially if the work is large or irregular in shape.

These recessing operations, however, can in most cases be easily accomplished in the drilling machine with a tool such as shown in the accompanying illustration. It will be seen that this tool is a modification of the old-fashioned flat drill. The operation of the tool may be explained as follows: Assume that it is required to drill the ¾-inch hole shown in the illustration 1 inch deep, and that the recess is ⅞ inch in diameter and ¼ inch deep. First drill the ¾-inch hole about 1⅛ inches deep in the usual manner. Then use the tool shown, the cutting part of which is equal in width to the diameter of the ¾-inch drilled hole. The point of this tool is ground off center, the amount of eccentricity being equal to one-half the difference between the diameter of the drilled hole and the recess, in this case $(⅞ - ¾) \div 2 = 1/16$ inch. The section of the tool which is ¾ inch wide should extend only about ⅛ inch, as indicated in the illustration. The sides and point of the drill should be backed off in the usual manner. The tool should be provided with a heavy shank, the diameter of which should not exceed ⅝ inch in this case, so that there will be 1/16 inch clearance all around when the tool is at work. In operation, the point follows in the center left by the point of the ¾-inch drill and as the cutting edge of one side is 7/16 inch from the center, it will cut a recess ⅞ inch in diameter. The whole width of the cutter being only ¾ inch, it may be brought to the center and lifted out of the hole when the recessing operation is completed.

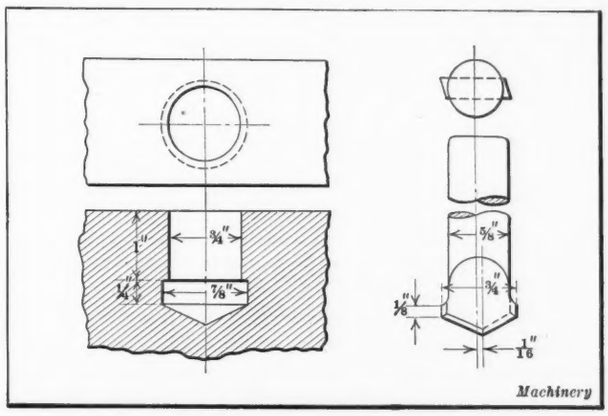


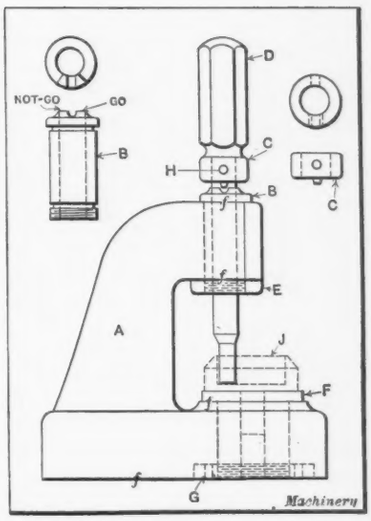
Illustration showing Dimensions of Recessed Hole and Tool used in Drilling Machine to bore Recess

Philadelphia, Pa. S. B. ROYAL

LIMIT GAGE

The accompanying illustration shows a limit gage which has proved to be one of the most practical designs yet evolved for gaging the thickness of the bottom of a bobbin case. Limit gages embodying the same general principles could be made for gaging similar work which would doubtless prove equally as satisfactory. The gage has a cast-iron body *A* having four finished surfaces which must be parallel to each other. The head of the bushing *B* is so designed that proper limits can be established by the points "Not Go" and "Go." This bushing is made from machine steel and is casehardened and ground. The machine steel collar *C* is also casehardened and ground and is a drive fit on spindle *D*. The pin *H* is used simply to fasten the collar in a fixed position on spindle *D*. Spindle *D* is made from standard machine-steel hexagonal stock and is casehardened and ground to a sliding fit in bushing *B*. The parts *E* and *G* are machine steel nuts employed to hold the bushings in a fixed position.

The gage is used in the following manner: First, the spindle *D* is raised a sufficient height to allow the stem of the bobbin case *J* to be inserted in bushing *F*. The end of the spindle should then be brought into contact with the work, care being taken to have the tongue on collar *C* located in the relieved portion of bushing *B*. Should the bottom of the bobbin case *J* be too thin, the tongue on collar *C* will prevent the spindle from being turned counterclockwise by coming in contact with the surface designated "Go." Should the bottom of piece *J* be too thick, the tongue will pass over the point designated "Not Go" when turned in the opposite direction. If the thickness of the bottom of piece *J* is correct, the tongue will pass over the "Go" point, but not over the point designated "Not Go." It will be observed that the parts of this gage are so designed that they may be easily removed and repaired if necessary. This is a distinct advantage in gages of this type which are subjected to constant wear.



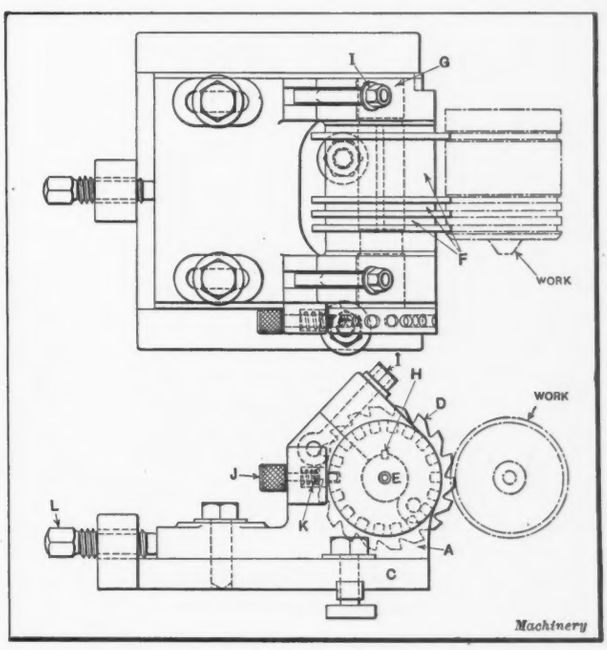
Limit Gage designed to gage Thickness of Bobbin Case

Bridgeport, Conn. MAX SLUTZKY

MULTIPLE TOOL-HOLDING FIXTURE FOR GROOVING PISTONS

In the accompanying illustration is shown a multiple tool-holding fixture for grooving pistons, which was designed by the writer. The principal advantage possessed by this device is that circular milling cutters are used in place of single-point tools such as are usually employed. Each of the circular cutters has eighteen teeth, thus allowing eighteen different cutting edges to be employed successively before resharpening becomes necessary. Two arbors and two sets of cutters are provided so that one set may be sent to the toolroom to be ground while the other is in use.

Referring to the illustration, casting *A* is fastened to the



Multiple Tool-holding Fixture for grooving Pistons

machined base *C*, which, in turn, is fastened to the carriage of the lathe. The cutters *D* are assembled on the arbor *E*, being properly spaced by collars *F*. Nut *G* and key *H* serve to hold the cutters securely in position on the arbor. The split bushings in which the ends of the arbor rest are tightened by two lock-nuts *I*. When one set of cutter teeth becomes dull, nuts *I* are loosened and the arbor indexed to bring the next set of teeth into the proper cutting position. The plunger *J* which is normally held in the position shown by means of spring *K*, must, of course, be withdrawn before indexing the arbor. The screw *L* is provided simply to facilitate proper adjustment of the fixture after the cutters have been ground.

Lansing, Mich. O. H. KARCHER

DESIGNING DIES FOR SAFETY

Dies designed to prevent accident or injury to the operator often increase productive capacity besides affording greater safety. In this connection the writer recalls a die, the design of which required the operator to put his hand under the punch when placing the work in position. This die produced a right-angle bend in a piece of work *W*, shown between the punch and die, Fig. 1, and also in the guides in Fig. 2. This piece is made of 24-gage galvanized iron, and has two sides and one end turned up as shown. With the original die shown in Fig. 1, the operations were as follows: A piece was picked up with one hand and passed to the other in the correct position for placing in the die, and with the index finger extending along the piece. While held in this manner, the piece was pushed to the left, knocking the finished piece from under the punch. It was then placed in the correct position over the die and slid to the right, the end flange acting as a stop to locate it longitudinally.

In grasping the piece, the operator frequently caught hold of it with his index finger extending so far along the piece that there seemed danger of its becoming caught between the punch and die. It was therefore decided to change the die so that it could be operated under an inclinable press, as it could then be fed by gravity. The positions of the punch and die were reversed in the new design, shown in Fig. 2. This arrangement permits the work to slide down the guides with the flanges up. There is a guide at each end of the work made of two angle-irons *A* and *B*, formed from 14-gage sheet iron and riveted to short pieces of 1½-inch angle-iron *D*. The two lower guides *A* extend beyond the end of the upper guides *B*, thus forming a table on which the work is placed when the slide is being filled. The guides *A* end at the beginning of the bottom former *F*, but the upper guides *B* continue far enough to allow the work to slide over the bottom former and against the stops located at *E*. The work will then rest on the bottom former, and as the right-hand side is longer than the left, the left side will tip up until it bears against guide *B*. There being no lower

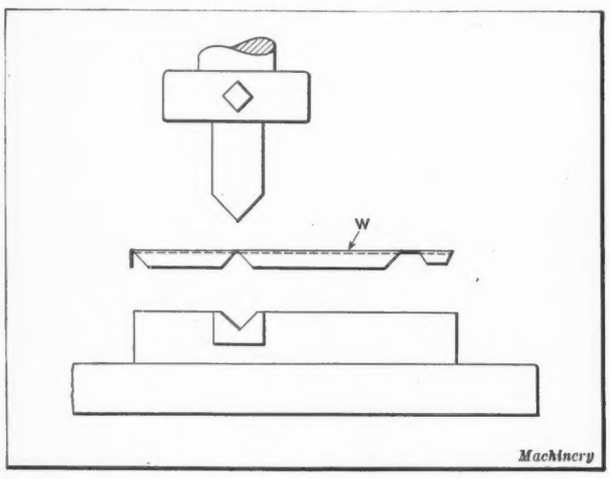


Fig. 1. Die employed to produce Right-angle Bends

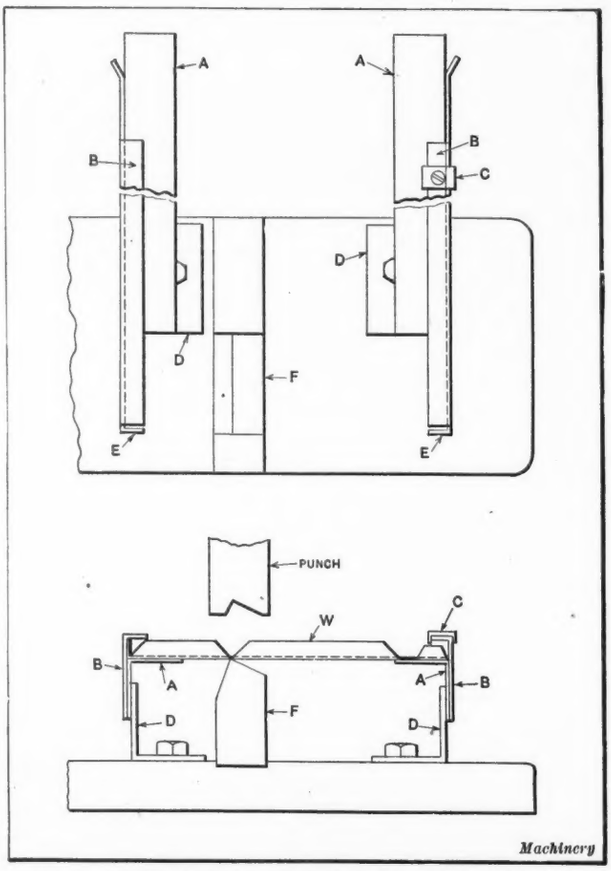


Fig. 2. Improved Design of Bending Die, which reduced the Possibility of Injury and also increased Production

guides at this place, space is allowed for the ends to pass down as they are formed by the punch. The finished work can then pass out of the back of the press.

After this die had been in operation for a short time the operator suggested that a stop be put on the slide in such a position that it would prevent any piece of work from being placed incorrectly in the slide. By referring to the illustrations it will be seen that the height of the flange on the right-hand end of the work is less than that of the other flanges of the piece. By making a stop *C* to catch any piece that might enter in a reverse position, all loss from this source was stopped. With this die, the operations consist merely of placing the pieces in the slide and allowing the press to run until the slide is nearly empty, at which time the press must be stopped and refilled. This is necessary because the pieces cannot be placed in the guides as fast as the press operates. This scheme proved entirely satisfactory from a safety point of view and has also more than doubled production.

Evanston, Ohio WALTER H. WEBSTER

MILLING MACHINE KINK

The following method of adjusting the index-head center to the same height as the center of the milling machine spindle is frequently employed by the writer and may be of value to others. A piece of machine steel is first turned to some convenient decimal diameter and placed in the spindle chuck, after which the arbor is placed between the index-head and footstock centers. The arbor must be true and its decimal diameter known. The table is then raised so that a feeler will be held snugly between the arbor and the turned piece in the milling machine chuck. The additional amount, of course, required to raise the table to the desired height is equal to the thickness of the feeler plus one-half the sum of the diameters of the arbor and the turned piece in the chuck. This will locate the table accurately in the desired position.

Brazil, Ind. OSCAR CRAFT

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

Toledo Vertical Milling Machine. Toledo Milling Machine Co., Toledo, Ohio 363
Warner & Swasey No. 6 Turret Lathe. Warner & Swasey Co., Cleveland, Ohio 365
Sibley Drilling Machine. Sibley Machine Co., 8 Tutt St., South Bend, Ind. 366
Cleveland Face Grinding Machine. Cleveland Machine Tool Co., 3215 Superior Ave., Cleveland, Ohio 366
Toledo Traveling Wall Crane. Toledo Bridge & Crane Co., Toledo, Ohio 367
United Molding and Tube-rolling Mill. United Machine & Mfg. Co., Canton, Ohio 368
"Stamco" Crank Shaper. Streine Tool & Mfg. Co., New Bremen, Ohio 368
Eclipse Inverted Counterbore. Eclipse Interchangeable Counterbore Co., Inc., Detroit, Mich 369
Fosdick Pneumatic and Hand Radial Drill Column Clamp. Fosdick Machine Tool Co., Cincinnati, Ohio 369
Foster Hand Screw Machines. Foster Machine Co., Elkhart, Ind. 370
Urban Bench Lathe. Urban Machine & Tool Co., 2424-2430 St. Clair Ave., Cleveland, Ohio 372
American Pneumatic Milling Vise. American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill. 372
Robinson Adjustable Lathe Center. Robinson Adjustable Center Co., 1310 Twelfth St., Detroit, Mich. 373
Economy Parallel Ruler Attachment. Economy Drawing Table & Mfg. Co., Adrian, Mich. 373
Lovejoy Right-hand Tool. Lovejoy Tool Co., Inc., Springfield, Vt. 374
H. H. Arnold Reamers and Counterbores. H. H. Arnold Co., Rockland, Mass. 374
Cowan Metal Feet for Transveyor Skids. Cowan Truck Co., 16 Water St., Holyoke, Mass. 374
E. F. Hauserman Tote-box. E. F. Hauserman Co., Cleveland, Ohio 374
Elwell-Parker Electric Shell Truck. Elwell-Parker Electric Co., Cleveland, Ohio 375

Toledo Vertical Milling Machine

The Toledo Milling Machine Co., Toledo, Ohio, has placed on the market a vertical milling machine that is illustrated in Figs. 1 and 2. This machine, which is styled the No. 3-V, is the first of a line of millers that will be developed by this concern. In working out construction details, an effort was made by the designers to attain the maximum degree of rigidity for the machine and consequent accuracy of the work produced on it. For use in toolmaking and die-sinking, it is believed that there is a demand for a vertical milling machine that would operate on very heavy dies and similar work, providing for accurate heavy milling, even upon the extreme ends of such dies, without deflection, chattering, or impairment of accuracy.

Attention is called to the design and weight of the main column of this miller. It is machined from a casting weighing 1½ tons, and the metal is so proportioned as to give the greatest resistance against strain. The base of the column is made particularly heavy, which is a feature that enables the machine to work on large drop-forging die-blocks, taking milling cuts to the very ends without chatter or deflection or unbalancing of the machine. As a test, a 1,000-pound die was held upon the table and traversed to bring the extreme end of the block under the milling cutter. The machine was not bolted to the floor and even without taking this precaution, it is said that the operation was as smooth as though the block and table were at the center.

The unit construction idea has been followed in designing this machine. Not only are the table, saddle and knee quickly removable, but the feed-gear case with its gears intact may be taken off by simply removing six screws.

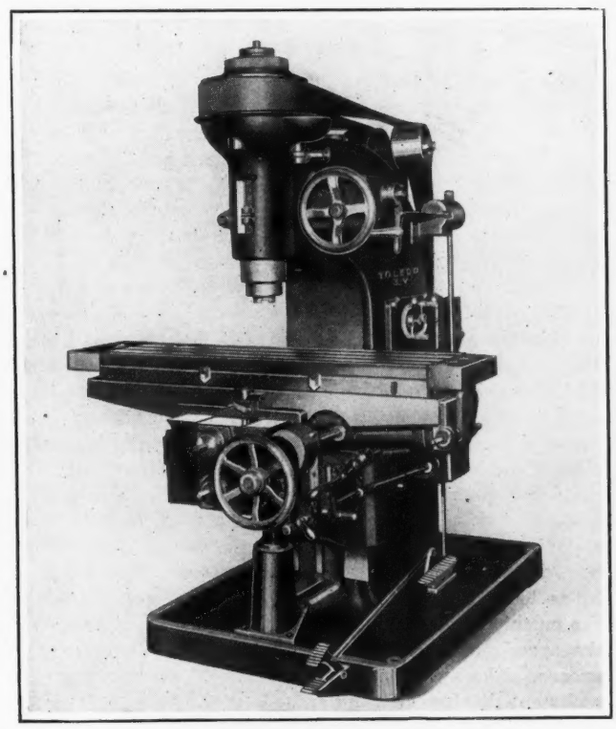


Fig. 1. Vertical Spindle Milling Machine Built by the Toledo Milling Machine Co.

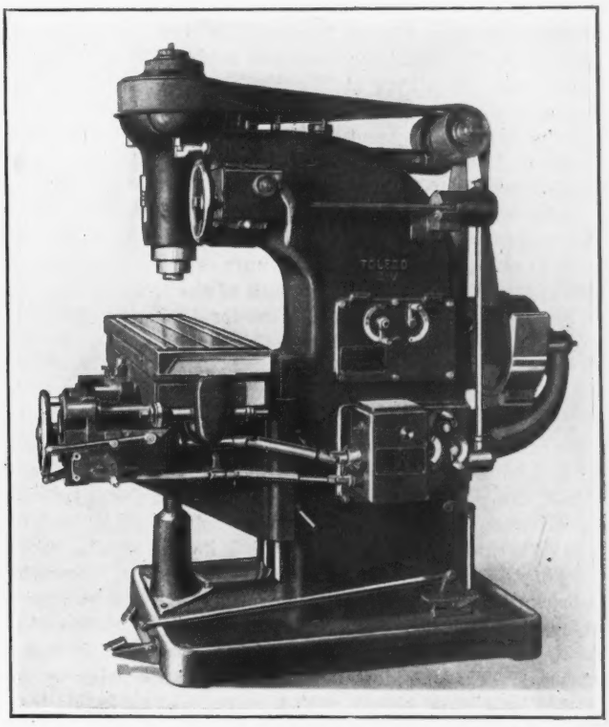


Fig. 2. Side View of the Toledo No. 3-V Vertical Spindle Milling Machine

Similarly, the speed gears and their case may be removed; the spindle and its bearings in the sleeve are quickly removable; and the same is true of the spindle feed-box and the knee and table reverse gears. Although this machine is a general-purpose miller, and is said to be as well adapted for manufacturing as for tool work, a feature that will appeal to die-sinkers and toolmakers is the central control of all table and spindle movements. From the one operating position at the front, all the movements of the machine, except for feed and speed changes, are under control. This is a feature in machine tool design that is being given more and more attention.

The Knee and Table

The knee is of conventional design and liberally proportioned. The usual ball bearing telescopic elevating screw is provided. Particular attention is called to the manner of mounting the knee upon the column. This mounting is arranged on a tapered central gib principle but the bearing surfaces are made of exceptional width. Here again, the object of this method of mounting is to provide extreme accuracy on heavy die work. In operation, it has been proved that accurate cuts could be taken, even without tightening the usual knee binders that are provided. The saddle and table are extra heavy and of box construction. The saddle is made 4 inches longer than the table proper, to provide an additional support when at the extreme ends of its travel, the question of support being well taken care of by the extra wide bearing of the saddle upon the knee.

Knee, Saddle, and Table Movements

Movements of the knee, saddle, and table are all controlled from one operating position, and the feed mechanism is so designed that it is absolutely impossible to engage any two feeds at the same time. Because of this feature the operator, even although he may be inexperienced, cannot possibly damage either the machine or the work from this cause. By means of engaging levers at the knee, any of the knee, saddle, or table movements may be put under control of the centrally located handwheel on the knee. This feature permits the operator to handle irregular work to the greatest possible advantage.

Rapid traverse of the knee, saddle, or table is secured from the rapid traverse lever at the front of the knee. In order to operate the rapid traverse movements, a plunger must be disengaged and the lever held in the proper position while the rapid traversing is taking place. When the quick traverse is applied to either the knee, saddle, or table movement, any other regular feed is automatically released by the same lever; and at the end of this rapid traverse movement, the original feed is again engaged by the return of the rapid traverse lever to its natural position. All knee, saddle, and table movements, whether forward or reverse, are controlled by the straight lever shown at the right-hand side of the knee in Fig. 1. At times, a vertical milling machine operator must be at the back of the table to watch the operation. For this reason, provision is also made to control the table movements from this position.

Spindle Construction

The method of mounting and driving the spindle is a feature of this vertical milling machine. The spindle is made of forged chrome-manganese steel and is ground to the finished size. The main section of the spindle is 3¼ inches in diameter and it runs in two phosphor-bronze bushings, each 4½ inches long and spaced 3 inches apart. These bushings are furnished with an oil reservoir from which lubricant is drawn. To provide means of compensating for wear, this main bearing is split and furnished with end adjusting nuts that enable the bearing to be closed in to take up wear. The outside taper of this bronze bearing is supported by a large sleeve, with a corresponding inside taper. The spindle sleeve is liberally proportioned to withstand the heaviest service. It is split for taking up wear, and in one of the recesses there is embedded a felt strip which acts as a retainer for lubricating oil. Mounted on one side of the spindle sleeve there is a steel rack with which the elevating gear meshes. End thrust of the spindle is taken by ball bearings at either end of the main bearings; and the pull of the spindle driving belt has no effect upon the main spindle bearing, because this pull is taken by a large auxiliary bearing at the top of the machine. In this bearing, which is adjustable, there are incorporated two specially designed ball bearings that take care of the spindle belt pull.

Spindle Lubrication

At the top of the spindle pulley and integral with it, there is an oil chamber holding sufficient oil for the lubrication of the auxiliary bearings, back-gear and spindle bearings. In addition to the auxiliary ball bearing that receives the belt pull of the spindle, the main driving shaft and idler pulleys are similarly mounted on ball bearings. Throughout the machine there are twenty-nine ball bearings, and all other bearings are bushed with phosphor-bronze. The spindle may be fed by hand or power. When feeding by hand, the large handwheel at the front controls the movement; and when it is pushed in, this handwheel feeds the spindle directly through the spur gear and rack previously mentioned. Conversely, when the handwheel is pulled out, the feeding is through a worm and wormwheel, thus providing for accurate control.

Speeds and Feeds

All speeds and feeds of this machine are in geometrical progression. Through the speed gears, sixteen changes are obtainable. With an open belt drive, eight changes of speed may be secured—97, 113, 141, 177, 226, 263, 329, and 411 revolutions per minute. The spindle is provided with back-gearing in the ratio of 5.5 to 1. By means of these back-gears the speeds obtainable are 18, 21, 26, 33, 42, 49, 61 and 76 revolutions per minute. There are sixteen rates of feed which are governed by the speed of revolution of the spindle. The feed-case is driven through spur gears directly from the spindle. Therefore, it is the speed of rotation of the spindle that absolutely controls the rates of feed. These feeds are in geometrical progression, and the available rates are 0.004, 0.006, 0.009, 0.013, 0.018, 0.025, 0.035, 0.049, 0.069, 0.094, 0.136, 0.186, 0.264, 0.361, 0.520 and 0.710 inch per spindle revolution.

Cutter Mounting

The spindle of this machine is provided with a No. 13 B. & S. taper. Cutters are attached to the spindle by a straight fit at the spindle nose, and they are held in place by a draw-bar and bolt, with an enlarged head. Also, there are two hardened steel keys secured in two slots at the spindle nose by screws. These keys engage similar slots in the cutter and thereby provide for driving it.

Range of Feeds

The following outline shows the range of feed movements on this machine: Longitudinal table movement, 46 inches; traverse table movement, 14 inches; vertical knee movement, 14 inches; and spindle feed, 6½ inches. Some of the important dimensions are: Throat distance, 19 inches; greatest distance from end of spindle to top of table, 22 inches; and size of table surface, 56 by 14 inches. There are three ⅝-inch T-slots and ⅜-inch tapped holes in the edge of the table for side straps. Starting and stopping of the machine is governed by a foot-treadle at the right, and oiling is accomplished from a central oil reservoir, from which oil tubes lead to the various bearings. All gears throughout the machine are of steel and heat-treated, with the gears in the speed- and feed-cases arranged to run continuously in grease. The machine may be equipped with a rotary attachment, having all regular and quick-traverse feeds; and it is readily adapted for motor drive. The total weight is 7000 pounds.

WARNER & SWASEY NO. 6 TURRET LATHE

To meet the demand for a turret lathe possessing ample power and strength for machining gear blanks, forgings, and various parts made of tough alloy steel, the Warner & Swasey Co., Cleveland, Ohio, has recently added to its line the No. 6 turret lathe which is here illustrated and described. This machine is said to be especially adapted for use in plants engaged in the manufacture of automobiles, tractors, and electrical apparatus, as well as in railroad and miscellaneous machine shops. It is equipped with double friction back-gears and either with or without an automatic chuck, bar feed mechanism and power feed to the turret; and either a standard or heavy duty carriage may be provided, according to the requirements. Nine spindle speeds are available, three for each step of the driving pulley, and the power obtainable with the double friction back gears permits of taking heavy forming and facing cuts on both bar and chucking jobs.

When used for severe service of this kind, the heavy duty carriage will be found to give the most desirable results. It is provided with power cross and hand longitudinal feeds, and the cross feed can also be operated by hand. Provision is made in the apron design for obtaining six power cross feeds and reverse, the three finer feeds being suitable for forming, and the three coarser ones for facing operations. The cross-slide is fitted with a dial graduated to 0.002 inch, and adjustable stops are provided for either direction. It is possible to swivel the front toolpost to any angle, and a cutting-off tool-holder is regularly furnished at the rear. Either of these tool-holders may be removed and forming or various other tools substituted.

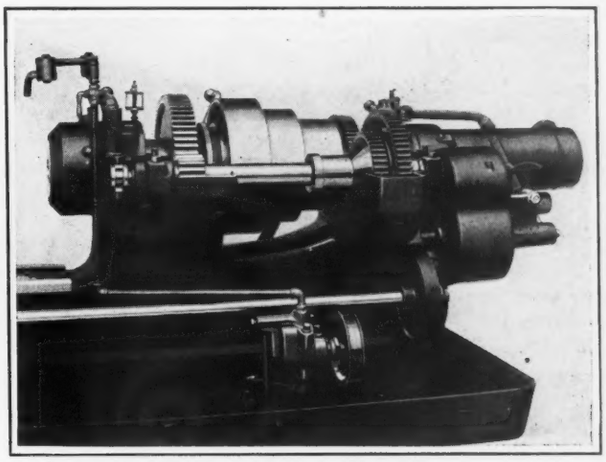


Fig. 2. Rear View of the Head End, showing Arrangement of the Back-gears

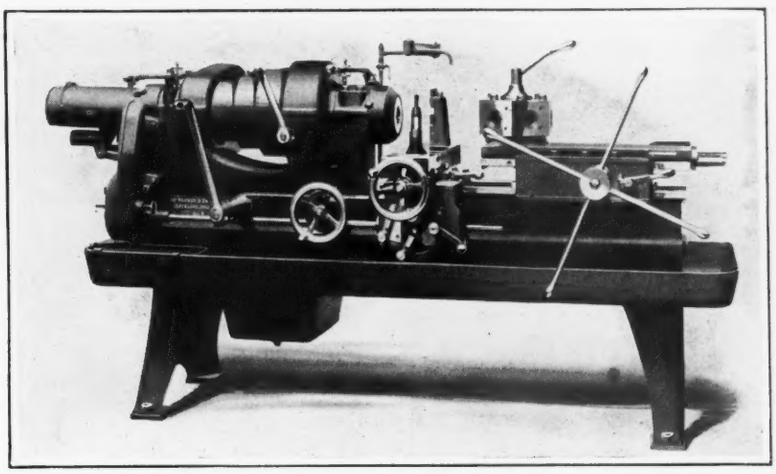


Fig. 1. No. 6 Heavy-duty Turret Lathe built by the Warner & Swasey Co.

When a standard carriage is furnished on this machine, it is of the type that has been used on Warner & Swasey turret lathes for several years, hand longitudinal and cross feeds being included among its regular features. Work requiring the use of power cross-feed is more conveniently handled with the heavy-duty carriage which has power cross-feed and adjustable stops for the cross-slide. The toolposts are similar to those previously mentioned. Both the automatic chuck and bar feed are operated by a long lever at the front of the head. A stepped wedge automatically adjusts the collet for slightly varying diameters, and a master collet and bushing pads are regularly furnished with this machine, for holding 2¼-inch round stock. Bushings for hexagonal stock can be held in this collet, but square stock requires a special master collet and bushing pads. Extra-capacity collets can also be furnished.

It will be seen that the head and bed are cast integral with each other. Provision is made for holding tools with or without shanks on the hexagonal turret. The turret is revolved automatically by the backward movement of the slide and the locking bolt is placed on the front end of the slide. It enters tapered steel bushings inserted in the bottom of the turret close to the outer edge and directly under the cutting tools. Independent adjustable stops operate automatically for each position of the turret and provide for disengaging the power feeds. A supplementary tapered base for the turret saddle provides for adjusting the tool holes in the turret to a position exactly opposite the center of the spindle; and tapered gibs fitted over the entire length of the saddle at each side provide means of adjusting the slide sidewise. Power feed for the turret-slide may be furnished as special equipment, and any of four changes is instantly obtainable by moving a lever. The automatic trip operates in connection with independent adjustable stops for each hole in the turret. The oil-pump is so designed that it operates when the machine is run in either direction. A complete line of standard turret lathe tools for use on this machine is kept in stock.

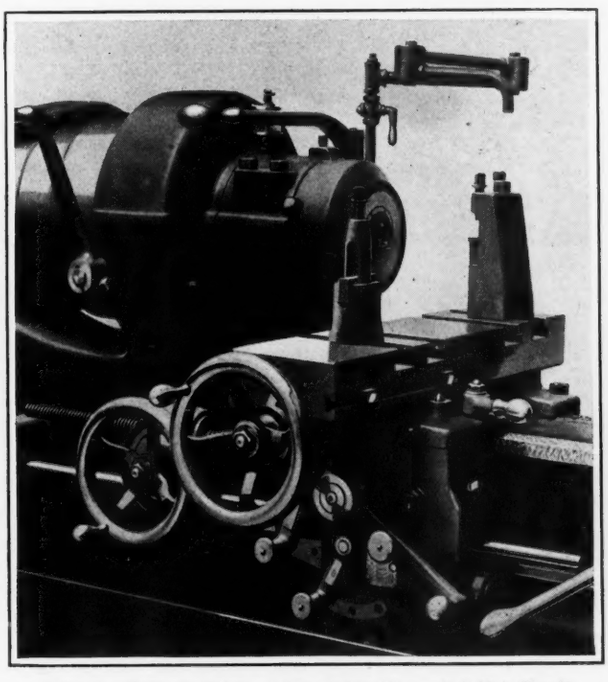


Fig. 3. Close-up View of the Cross-slide and Collet Chuck

SIBLEY DRILLING MACHINE

The Sibley Machine Co., 8 Tutt St., South Bend, Ind., has recently placed on the market a sliding-head drilling machine with positive geared feeds, in which proved features of preceding types of drilling machines of this company's manufacture have been incorporated together with a number of new ones. This machine is now being built with a swing of 24 inches, and it has been designed to meet the requirements of modern production methods. There is a wide range of selective speeds and feeds, and to adapt the machine for heavy duty the base has been substantially ribbed to give it the necessary strength and rigidity. T-slots on the base provide for clamping large pieces of work. The head and spindle are counterbalanced by a weight supported inside the column by a Diamond chain operating over large-diameter sheaves. All gears are enclosed to assure the safety of the operator, and belt guards can be furnished as a special equipment.

One of the new features of this machine is the fitting of all driving shaft bearings with die-cast split bushings made of anti-friction metal, these bushings being interchangeable and assuring long life for the bearings. There is plenty of movement for the head and spindle to provide for the use of large jigs. A ball thrust bearing is provided for the spindle. Another feature is the geared feed mechanism that provides four changes of feed and a neutral position. These feed-changes are obtained by moving a conveniently located knob in the center of the hand-wheel in connection with a sliding spline, four changes of feed being provided for each spindle speed. The initial drive of the feed-shaft is from the top cone-shaft through spur and spiral gears. Not only does this afford a compact construction, but it also allows the gears to be completely enclosed so that they may run in oil. A steel worm which meshes with the large wormwheel also runs in an oil-pocket.

An adjustable automatic stop of new design is quick and positive in action. Hand feed and quick return of the spindle is effected through the medium of a three-legged spider located at the right-hand side of the feed-box. Special attention has been paid to the provision of means for lubricating this machine. All bearings are equipped with oil-cups and channels, insuring proper distribution of oil to the vital points. The loose pulley is furnished with a self-oiling bearing and will run for several months without requiring attention, while all of the feed-gears are completely enclosed and arranged to run in oil. A positive geared tapping attachment, geared or belted motor drive, a round or square table with T-slots and an oil-pocket, an oil-pump outfit, and a quarter-turn countershaft can be furnished as special equipments for use on this drilling machine.

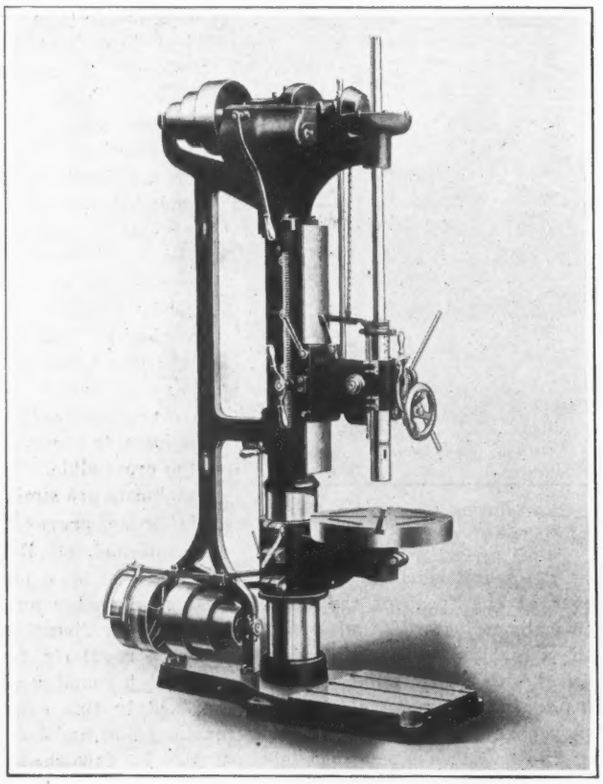


Fig. 1. Sliding-head Drilling Machine Built by the Sibley Machine Co.

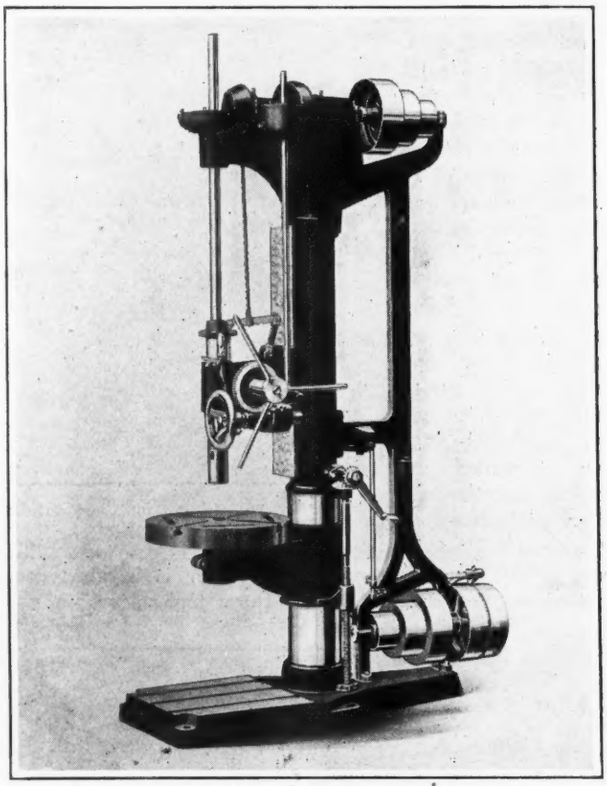


Fig. 2. Opposite Side of the Sibley Drilling Machine shown in Fig. 1

CLEVELAND FACE GRINDING MACHINE

For use in grinding metal slitting saws, hubs of milling cutters, faces of bushings, arbor collars, and for the performance of a great variety of similar face grinding operations that come within its range, the Cleveland Machine Tool Co., 3215 Superior Ave., Cleveland, Ohio, has recently placed on the market a face grinding machine which is here illustrated and described. This machine is constructed with an L-shaped column of one-piece box section, which affords ample strength and rigidity. There is a door at the front, permitting easy access to the working parts for oiling and adjustment, and in Fig. 1 the machine is illustrated with the column partially broken away in order to show the mechanism. There is also a door at the side, as shown in Fig. 2, which makes a large part of the space in the column available for the storage of tools, grinding wheels, etc.

One V-shaped and one flat way support the table, which is made larger than the ways so that the bearings are always covered and kept free from dust and grit. A crank-handle adjustment is provided for the table, by means of which the arc of oscillation can be readily changed to meet the requirements of different jobs. The table is oscillated by a crank disk driven by a worm and wheel, which assures a uniform motion. Adjustment of the arc of oscillation ranges from 0 to 6 inches, which means that work up to 12

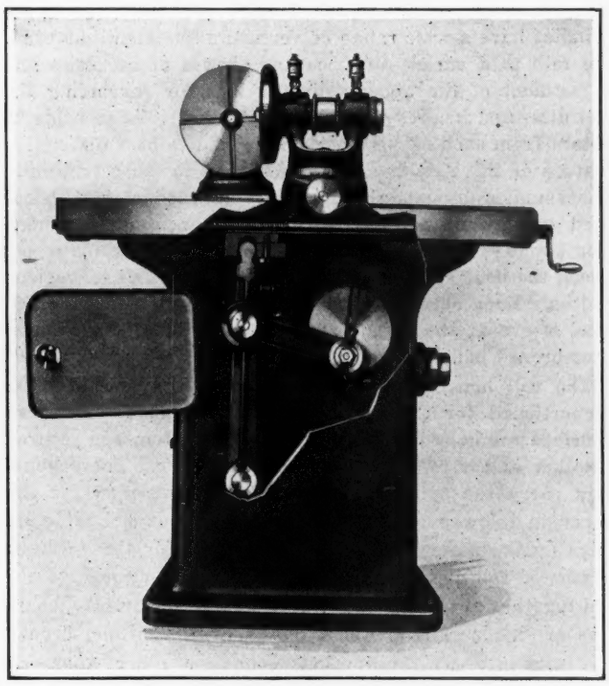


Fig. 1. Face Grinding Machine Built by the Cleveland Machine Tool Co.

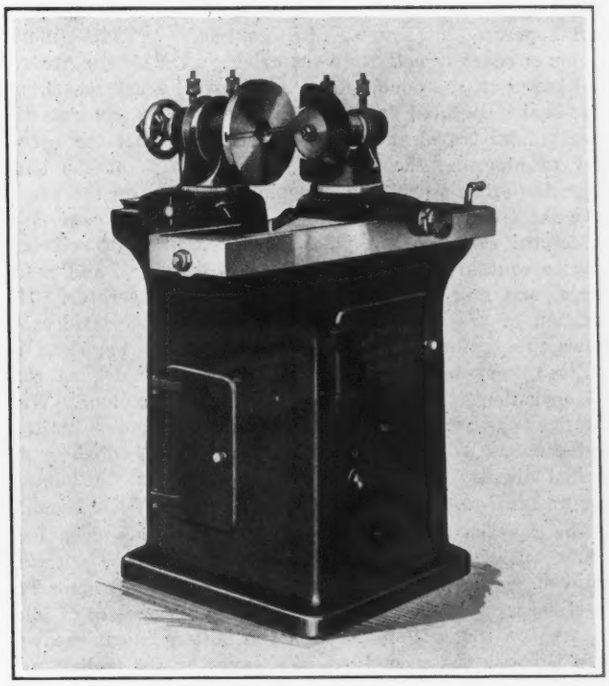


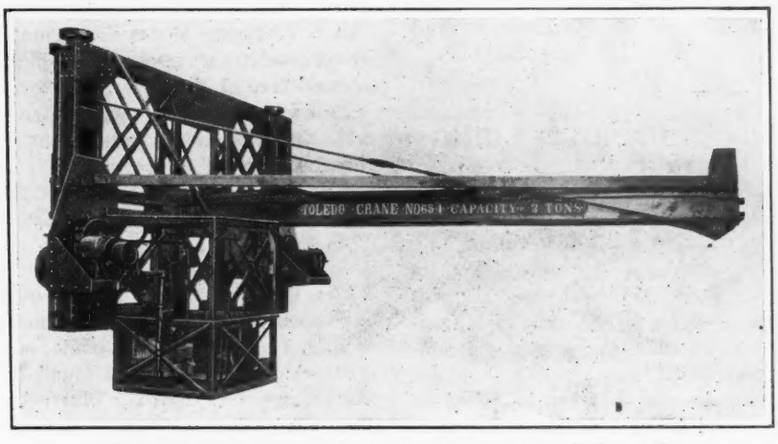
Fig. 2. View of Cleveland Face Grinding Machine showing the Door in the Side

inches in diameter may be ground. Six changes of feed are available, any of which can be obtained by means of a three-step cone pulley and a two-speed countershaft.

A dovetail slide supports the saddle on which the grinding wheel head is mounted. This saddle has a lateral adjustment of 2 inches on the table and is designed so that dust is excluded from the bearing surfaces. The saddle adjusting screw is equipped with a micrometer dial and the grinding wheel head is pivoted and can be turned to any desired angle, thus permitting the use of wheels of various shapes. The head is graduated in degrees over an arc of 30 degrees. A special grade of steel is used for making the grinding wheel spindle which is hardened and ground and runs in phosphor-bronze bearings. Large grinding wheel flanges are provided and also a wheel guard large enough to accommodate wheels up to 8 inches in diameter.

The work-head is secured to the wing of the column by a dovetail slide, and rests on its own saddle which has a longitudinal adjustment of 6 inches. A hand clamping screw fastens the saddle to the column, thus providing easy adjustment, and a gib makes this slide adjustable for wear. The machine will accommodate work up to 6 inches in thickness without overhang of the saddle, and by allowing the saddle to overhang slightly and using a grinding wheel approximately 5 inches in diameter, work exceeding 10 inches in thickness can be ground. By having the work-head pivoted on the saddle, it can be swung to any angle and is graduated in degrees to facilitate setting.

A No. 11 Brown & Sharpe taper hole is provided in the work-spindle which is hardened and ground and runs in phosphor-bronze bearings. The nose of the spindle is threaded to receive a 10-inch faceplate which has two 7/16-inch T-slots at right angles, permitting of rapid clamping of the work. Two draw-bolts and ½-inch and 1-inch collets are furnished as regular equipments. Especial attention has been given to provision for lubricating the bearings and protecting them from dust. All cylindrical and flat bearings, and all oil-holes have dustproof oil-caps, and the four spindle bearings are provided with large sight-feed oil-cups. The table and saddles are so constructed that their bearings are protected, and the spindle bearings are furnished with specially designed dust covers. A self-contained countershaft is used, which should run at 400 revolutions per minute.



Traveling Wall Crane Built by the Toledo Bridge & Crane Co.

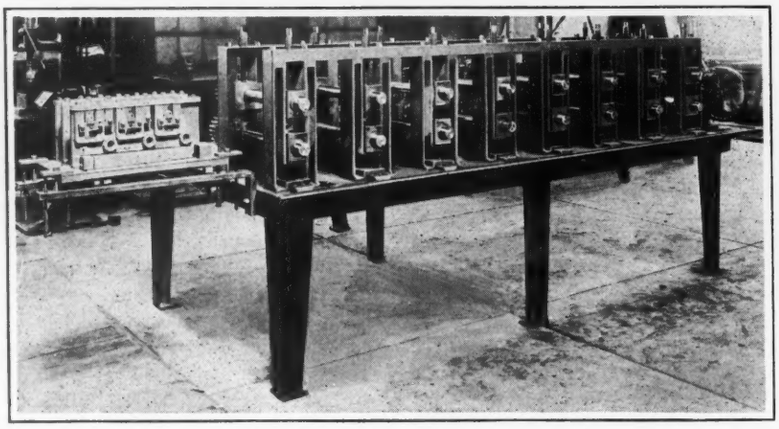
TOLEDO TRAVELING WALL CRANE

A traveling wall crane of the type described in this article has proved useful in a great many plants as an auxiliary to the standard overhead crane equipment or where the wall type is used exclusively. It has recently been placed on the market by the Toledo Bridge & Crane Co., Toledo, Ohio, and is regularly furnished in capacities of three and five tons, with an effective reach up to thirty feet. This traveling wall type of crane has proved in many plants a satisfactory solution of the handling problems. Used as an auxiliary to the overhead crane, it avoids delays and congestion and leaves the overhead cranes free for the heavier loads and longer runs. The design is of the four motor type and can be furnished with direct- or alternating-current motors.

The back framing and boom consist of rolled steel channels, beams, plates or angles, and truss rods or eye bars are used to give stability to the boom. Two motors are provided for

the longitudinal travel, which are connected in parallel and operated through one controller. The motor pinion engages directly into the driving gear that is pressed and keyed on the double-flanged cast-steel truck wheel. A foot-brake operated from the cage effectually controls the longitudinal travel and stops the crane without the necessity of plugging the motors. This brake is of the band type, the brake wheel being mounted directly on the armature shaft of one of the motors. The operator's cage is of structural steel, with a plank floor, and it is of sufficient size to contain all controllers, the switchboard, and resistance, and still leave ample room for the operator. The location of the cage is optional, and there is considerable leeway as to its position. When desired, the cage can be omitted, rope-operated controllers being provided so that all operations can be accomplished from the floor. With the floor-operated type of crane, the foot-brake is omitted and a solenoid brake substituted in its place, which is attached directly to one of the driving motors. A bumper bar and rail checks are provided at the end of the boom.

The hoisting mechanism consists of a one-piece cast frame on which is mounted the hoisting motor with its train of gears, the solenoid brake and hoisting drum. The hoisting cable leads from the drum through one set of idler sheaves on the trolley, through the bottom block sheaves, then through the second set of sheaves on the trolley, and is anchored at the end of the boom. The solenoid brake performs two functions. It serves to stop the motor, thus providing for rapid reversal, and it also acts as a holding brake when the load is brought to rest through the dynamic braking control. The brake wheel is mounted direct on the extended armature shaft and is accurately machined and balanced. The brake is automatic in its operation and is so arranged and connected that should the supply of current fail or when the controller is brought to the neutral or off position, the brake at once becomes operative, prevents the load from falling or slipping, and is released only by the application of power or by spreading the brake arms against the tension of the springs. When alternating-current motors are used, the hoist motor is provided with a solenoid brake, and as a holding brake the hoisting mechanism is equipped with a band type of mechanical brake. This brake is of the screw friction type, is automatic in operation, and the load can only be lowered by power operating in the lowering direction.



Molding and Tube-rolling Mill Built by the United Machine & Mfg. Co.

UNITED MOLDING AND TUBE-ROLLING MILL

The United Machine & Mfg. Co., Canton, Ohio, is now building an eight-spindle molding and tube-rolling mill which will produce sections having a developed width up to 13 inches at a speed of from 60 to 300 feet of finished molding or tubing per minute, the exact rate of output depending upon the width of the stock that is used and the complexity of the section to be produced. Eight sets of spindles give a wide range of section designs that can be rolled on this mill. Both the upper and lower spindles are power-driven, thus insuring a positive rolling action and a high class of workmanship in the finished product. The upper spindles have a wide range of vertical adjustment, adapting the mill to a variety of sizes and shapes of sections; and adjustment of the upper rolls provides for regrinding the roll dies, and insures the longest life that it is possible to obtain from each set of dies; this is said to be a distinctive feature of this machine that is found in no other tube mill. The spindles are made of high-carbon crucible steel, hardened and ground and carried in phosphor-bronze bearings. The keyways are cut for the full length of the spindles between the housings to permit the use of roll dies of various widths. Each spindle is enclosed and keyed to a hardened steel sleeve at the front housing, which runs in the phosphor-bronze housing bearing.

The roll housings are made of cast iron and liberally proportioned for the service required of them. The rear housings are bolted to the platen at the bottom and secured together at the top by a rolled steel tie-bar. These housings carry the spindle, gear and pinion bearings for the upper and lower roll dies. The front housings slide on ways on the platen, providing adjustment for the different widths of roll dies that may be used, and the housings are tied together at the top with a rolled-steel tie-bar. All bearings are made of ample size, bushed with phosphor-bronze and arranged with oil-pockets, cups or other approved means of lubrication. The arrangement of the gearing distributes power equally to the eight sets of spindles. Initial drive is from the rawhide motor pinion to the main distributing gears, and thence by gear and pinion reductions to the final drive of each set of rolls. All pinions are made of heat-treated high-carbon cast steel with cut teeth, and all gears are guarded.

The feeding-in device or guide is composed of a set of horizontal tool-steel rolls, hardened and ground and mounted in phosphor-bronze bearings, which, in turn, are carried in a housing having vertical adjustment. Different widths of stock are guided into the die rolls by the vertical grooved rolls of the feeding-in device, which are mounted on spindles carried on an adjustable cross-slide. The set of straightening rolls provides for straightening the finished product as it comes from the run-out end of the mill. These rolls are run in bronze bearings provided with means of lubrication. The roll bearing blocks are mounted in housings that can be adjusted transversely on the platen without changing the vertical feed of the rolls.

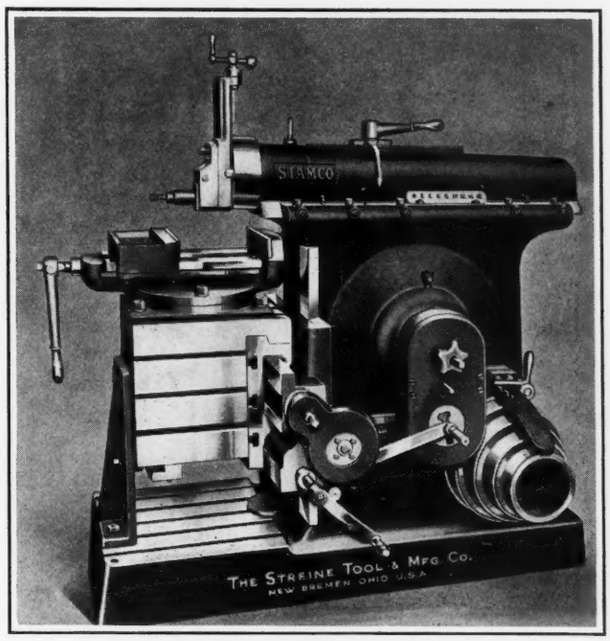
This mill is driven by one 25-horsepower multi-speed General Electric alternating-current motor, controlled by a rheostat starter, which, in turn, is operated by an extension handle running the full length of the tube mill.

"STAMCO" CRANK SHAPER

The 16-inch "Stamco" heavy-duty crank shaper, which has recently been placed on the market by the Streine Tool & Mfg. Co., New Bremen, Ohio, has a base of an extended type, which affords a solid foundation for the machine. It will be apparent from the illustration that there is a large plain surface on the base, which is furnished with T-slots running back to the column to provide for setting up large

pieces of work. This is a heavy-duty machine, and to afford a rigid construction, the column has been liberally proportioned and made of ample size at the base, thus lowering the center of gravity and providing a strong joint between the base and column. The bull-gear bearings are cast solid in the frame and have a large projected area, these two features being the means of effectually eliminating danger of excessive wear or tendency for the bearings to spring out of alignment. The total area of the bull-gear bearings is 205 square inches.

There are extended hubs on the bull pinion on which the intermediate gears are mounted on bronze bushings, as in planer construction. The driving gears are mounted on a long sleeve which slides on a key in the pulley shaft, the ratio of gearing being so arranged that the ram speeds are in geometrical progression. There are no conflicting gear ratios. A sleeve bearing bolted to the column supports the pulley in such a way that the shaft is relieved of all belt pull; and in this way all undue strain is taken off the shaft. A liberally proportioned bearing supports the ram, and by having a large projected area, unit pressure is reduced to a point where there is said to be practically no wear. The ram is clamped to a dovetail slide on the column, similar to the arrangement employed in milling machine construction; and the saddle fits into the narrow guide on the rail.

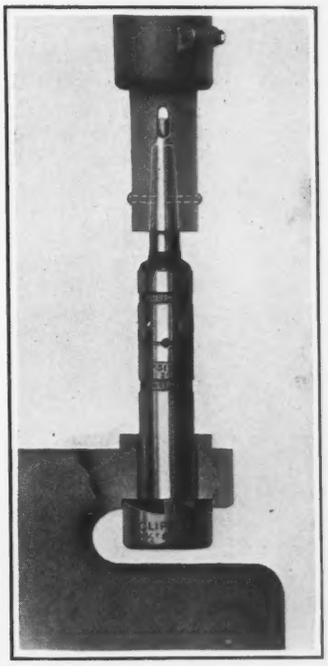


"Stamco" 16-inch Crank Shaper Built by the Streine Tool & Mfg. Co.

A telescopic elevating screw, provided with a ball thrust bearing, regulates the position of the table. As previously mentioned, large pieces of work can be bolted to the saddle or base after the table has been removed. A vise of substantial construction is furnished for use on this machine. Provision is made for varying or reversing the feed while the machine is operating, and any desired rate of feed can be instantly obtained. All adjustments are placed within easy reach of the operator and can be made while the machine is in motion. Micrometer collars graduated to 0.001 inch are furnished on all adjusting screws; and the head and vise are graduated in degrees.

ECLIPSE INVERTED COUNTERBORE

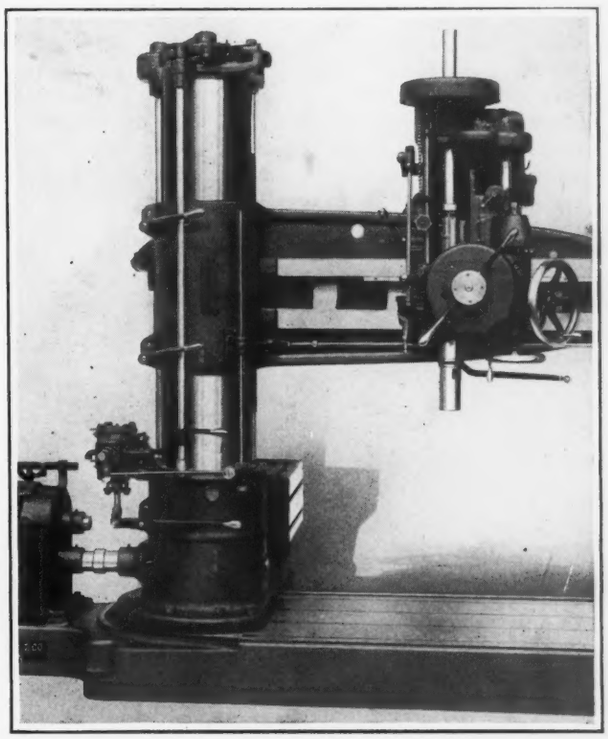
The advantages claimed for an inverted counterbore recently developed by the Eclipse Interchangeable Counterbore Co., Inc., Detroit, Mich., are that it may be attached and detached very quickly by hand without requiring the use of wrenches or screw-drivers. There are numerous classes of inverted counterboring and back-facing operations for which a tool of this type is adapted, and attention is drawn to the fact that this inverted counterbore has been standardized with other tools of this company's manufacture, so that it is interchangeable in much the same way as the standard Eclipse counterbores are. In other words, the inverted counterbore of a certain size will fit any of the piloted shanks of different diameters and vice versa. This tool is especially adapted for use with standard Eclipse counterbore holders, but it is also manufactured with a straight or a tapered shank. As shown in the accompanying illustration, it will be evident that the shank of the tool is inserted through a hole in the work to be faced and through the hole in the cutter, after which the cutter is given a slight turn to lock it in place ready for work. To detach the cutter, it is turned in the opposite direction.



Eclipse Inverted Counterbore

FOSDICK PNEUMATIC AND HAND RADIAL DRILL COLUMN CLAMP

For use in clamping the column of 4-, 5-, or 6-foot heavy-duty radial drilling machines of its manufacture the Fosdick Machine Tool Co., Cincinnati, Ohio, has recently developed a combination pneumatic and hand-operated device which is here illustrated and described. The most noticeable feature is the location of the cylinder, which not only brings the pressure directly to the point of clamping, but eliminates quite a number of the usual working parts. It will operate



Fosdick Radial Drilling Machine Equipped with the Combination Pneumatic and Hand-operated Column Clamping Device

equally well on extremely high or extremely low pressure, and during tests operated very successfully on a pressure of 45 pounds. Relief valves are provided at each end of the cylinder, and they are regularly set for a pressure of 45 pounds, although 150 pounds or more will show no shock or jar in clamping or unclamping. This condition is secured by an air cushion at each end of the cylinder, formed by additional ports in the valve to cause a compression at the proper termination of each stroke. The valve (a six-ported flat-disk valve) is operated by mechanical connection to a horizontal shifter bar running along the entire length of the radial arm. The advantage of this device is that it has no connection with, and does not interfere with the moving of the spindle head. The advantage of the combination hand clamping feature will be appreciated by those experienced with air-operating devices. In case of failure of the air, petcocks at each end of the cylinder are opened, and the ordinary method of clamping by hand is used.

FOSTER HAND SCREW MACHINES

The Foster Machine Co., Elkhart, Ind., has recently brought out a complete line of hand screw machines embracing five sizes. These are to be known as the Nos. 0, 1, 3, 5, and 7, and they have respective capacities for holding bars 7/16, 13/16, 1 5/16, 1 13/16 and 2 9/16 inches in diameter. Several new features, which will be fully described later in this article, have been perfected and incorporated in the designs. Taken as a whole, however, these machines do not represent a radical departure from established practice in building hand screw machines, but they combine the latest developments in this type of machine in their construction. The power and rigidity that are provided are in excess of the requirements of the most modern tools made of high-speed steel and stellite. A margin above these maximum requirements has been added with the view of providing for any improvements in tool steels that may be made during the next few years.

Unit Principle of Construction

The unit principle of design has been carried out throughout this entire line of machines. As applied in the Foster hand screw machines, each individual machine is assembled from a number of separate units built and kept in stock, ready for delivery to the assembling department. This affords a considerable amount of flexibility in meeting the requirements of individual consignees to whom the machines are shipped. Three different styles of cut-off units, namely, the lever feed cut-off, hand screw feed cut-off and power feed cut-off are being built. These are interchangeable and any of the three can be furnished. Power feed to the turret is provided by a separate unit, and a machine can therefore be built with either power feed to the turret slide or with hand feed. The automatic chuck and bar feed are independent units and can be furnished or omitted as required. Comprehensive sets of jigs and fixtures have been developed for the interchangeable manufacture of the various parts and units entering into the construction of each one of the various sizes of machines.

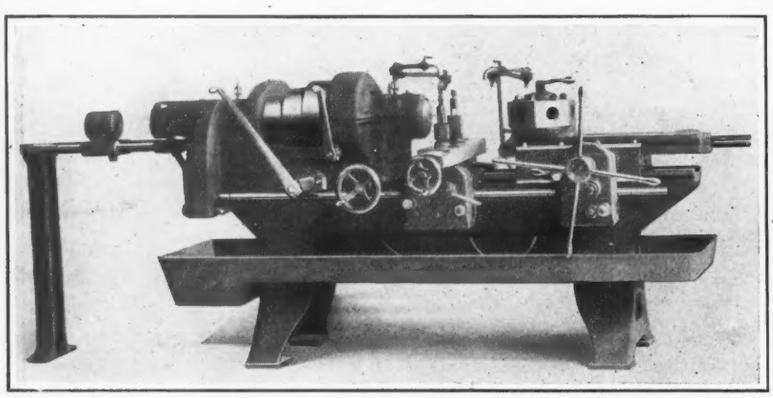


Fig. 1. Front View of the No. 7 Hand Screw Machine Built by the Foster Machine Co.

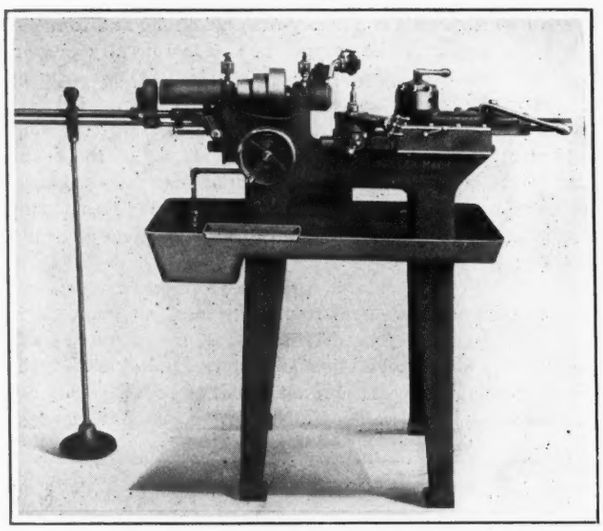


Fig. 2. Foster No. 0 Hand Screw Machine—the Smallest Size

Capacities of the Different Sizes

The No. 0 and No. 1 screw machines, which are of 7/16 inch and 13/16 inch bar capacity, respectively, are designed for high spindle speeds, and they have the sensitiveness of operation which is so essential in machines of the smaller sizes. They are built only in the three-step cone pulley plain head type. The turret-slide, which is operated by means of a hand-lever, has an effective longitudinal movement of 3 inches for the No. 0 machine and 5 inches for the No. 1 size. The No. 0 machine can be equipped with a compound rest, which is interchangeable with the lever feed cut-off, ordinarily furnished with this machine. On the No. 3 machine, the bar capacity of which is 1 5/16 inches, both plain head and friction head types are built. The No. 5 and No. 7 sizes, which are of 1 13/16 and 2 9/16 inches bar capacity, respectively, are built only in the friction head type. The large diameter cone pulley and the powerful friction provide more than ample power for the heaviest requirements. The turret-slide has an effective travel of 7 inches for the No. 3, 9 inches for the No. 5, and 11 inches for the No. 7 screw machine.

Design of the Head

Fig. 5 shows the friction head for the No. 5 Foster screw machine. The gear covers and spindle caps have been removed in order to more clearly show the design. A powerful friction clutch, mounted on the spindle between the cone pulley and the friction gear, serves to bring the spindle into driving connection directly with the cone pulley on one side or with the back-gears on the other. The frictions are of cone type and are operated by a hand-lever through the medium of a long movable sleeve and four fingers mounted on the spindle. This friction is very sensitive in operation and extremely powerful. The front and rear spindle bearings are made of a special grade of bearing bronze, and they are very liberally dimensioned. The spindle is made of a high-carbon steel forging. It will be noticed that the head is cast integral with the bed which is of a double girder type and heavily ribbed internally, a construction which is now found in various types of modern machine tools and which adds to the rigidity.

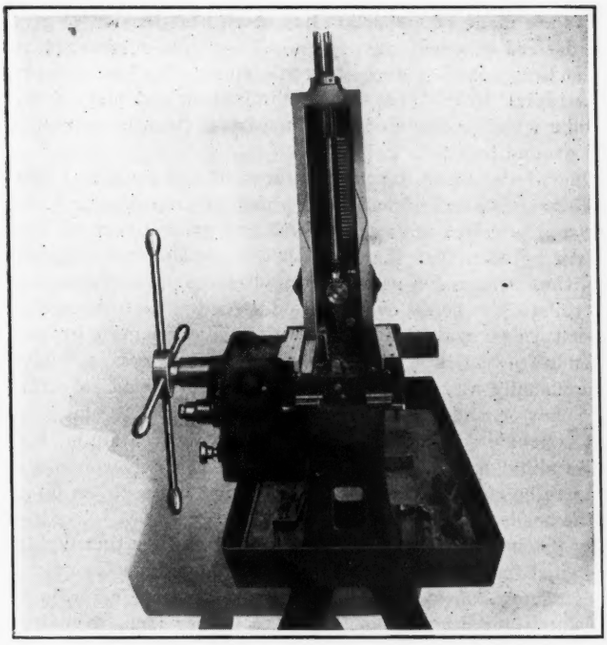


Fig. 3. Turret-slide and Saddle for the No. 3 Hand Screw Machine

Automatic Chuck and Bar Feed

Automatic chucks for use on these machines are of a standard spring collet type; and the automatic chuck hood and spindle nose have been designed to reduce the overhang from the front spindle bearing to a minimum. The collet-operating mechanism differs materially from the design which has heretofore been used by other screw machine manufacturers for this purpose. Instead of the well-known sliding fork principle, a fork-lever principle has been utilized, and the automatic chuck fingers have been equipped with rollers to eliminate friction at this point. This type of chuck mechanism enables an adequate gripping power to be applied by the chuck jaws through the application of only a moderate force to the operating lever. The bar-feed operating mechanism is also new in design. For the No. 0, No. 1, and No. 3 screw machines, a single supporting rod is used; but for the No. 5 and No. 7 machines, the stock support slides on two parallel bars. A continuation of the motion of the automatic chuck lever, as it opens the collet, feeds the bar forward. This is accomplished through a system of links and levers in such a manner that the automatic chuck and the bar feed are operated intermittently.

Turret-slide and Saddle

The No. 0 and No. 1 Foster screw machines are equipped with round turrets, while the No. 3, No. 5 and No. 7 sizes have hexagonal turrets, owing to the fact that flanged tools are desirable for handling the heavier work done on these machines. As previously mentioned, the turret-slide on the No. 0 and No. 1 machines is operated by a hand-lever pivoted on the top of the slide near the rear end. The turret indexing mechanism is very sensitive in operation. A vertical locking bolt is mounted underneath the front of the turret directly beneath the tool that is in operation. Fig. 3 shows a view of the No. 3 turret-slide and saddle with the slide tipped up and standing on its front end, and clearly illustrates the main working parts of the turret indexing mechanism. Attention is called to the fact that the end of the locking bolt lever, which intermittently engages the tumbler for withdrawing this bolt preliminary to the indexing of the turret, is equipped with a roller to increase its sensitiveness of operation and reduce wear. Backward travel of the slide indexes the turret by means of indexing pins in the bottom of the turret and a pawl pivoted in the saddle.

On the No. 3, No. 5, and No. 7 screw machines, a system of revolving independent stops is used, these stops being geared to the turret and indexed with it. The stop-screw working in conjunction with the working station of the turret abuts against a movable stop in the saddle. This stop stands in working relation with the mechanism, disengaging the automatic feed in the saddle apron. The system of independent stops for the No. 0 and No. 1 screw machines differs considerably from the one just described for the larger sizes. Instead of having the stops revolve with the turret, the stops are mounted in the end of the turret-slide. A revolving stop working in the slot between two lugs on the rear end of the saddle indexes with the turret and brings the proper stop into working relation with the forward turret station. Additional sensitiveness of indexing is obtained in this way, which is of especial importance in handling delicate work on small machines.

Power Feeds

At *B* in Fig. 4 there is shown the interior view of the power-feed apron for the turret-slide; and Fig. 3 shows the power-feed rack which is secured to the under side of the turret-slide. This rack engages the pinion on the long through shaft shown at *B* in Fig. 4. Motion is transmitted through a power feed-rod, seen on the front of the bed, to a worm and worm-gear in the apron, and three sliding gears provide means for obtaining the feed changes. These three changes are multiplied by a cluster of two sliding gears in the gear-box at the end of the machine, which provides six changes of feed. Provision is made for the power feed to be engaged and disengaged by a friction working in conjunction with a gear engaging the large driving gear of the pinion-shaft. A face cam on the outside of the apron and the drop-out lever serve the purpose of engaging the feed friction. This drop-out lever stands in working relation with the system of independent stops, as previously described. Attention is called to the fact that the apron is filled with oil up to a certain level and that the lower gears in the gear train, including the worm-gear, run in a bath of oil.

The cross-feed apron shown at *A* in Fig. 4 is similar in design to the saddle apron with the difference that additional sliding gears are introduced in the train to obtain a reverse of the feed movement. The feed friction which works in conjunction with the two large intermediate gears is operated by a rapid-acting and powerful cam, manipulated by a hand-lever. The power-feed apron together with the carriage and cut-off slide constitute a separate unit which is interchangeable with the hand screw cut-off, and also with the lever-operated cut-off, any of which three cut-off units can be furnished. A three-step sliding gear nests in the apron, in conjunction with the two changes obtainable in the gear-box, at the head end of the machine, as already described, and provides six changes of feed to the cross-slide.

An important feature of the design of this machine is

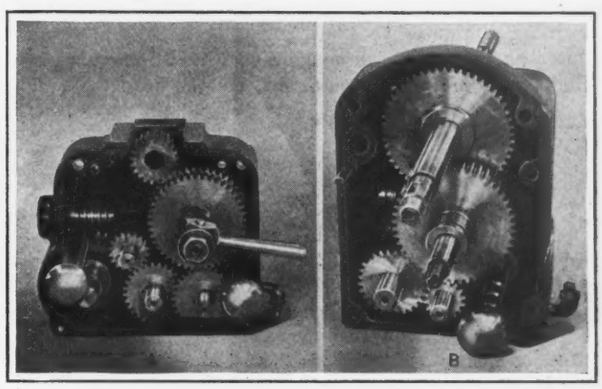


Fig. 4. (A) Apron for Power Feed to Cut-off for No. 3 Machine. (B) Apron for Power Feed to Turret-slide for No. 3 Machine—Covers removed

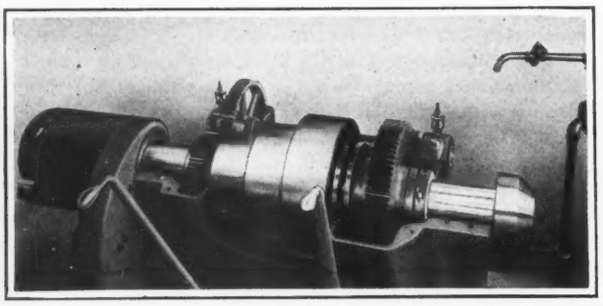


Fig. 5. Friction Head for the No. 5 Foster Hand Screw Machine

the location of the hand longitudinal feed-screw for the various cut-off units which is between the ways of the bed. The force moving the cut-off carriage on the bed is thus applied in the middle of the guide. Immediately inside the handwheel for the hand longitudinal feed there is mounted a large-diameter graduated dial equipped with observation stops. This facilitates the adjustment of the cut-off carriage longitudinally. A similar graduated dial with observation stops is also mounted on the cross-feed screw and used in conjunction with the movement of the cross-slide.

Control Systems

Attention is called to the centralized control and the ease with which the various control levers and knobs can be reached by the operator when standing in his natural position in front of the machine. All of the principal feed changes are located in the aprons. The lever operating the automatic chuck and also feeding the bar forward is placed within easy reach of the operator and, as already pointed out, it operates with unusual ease.

For applying the proper amount of coolant to the work and the cutting tools, the larger machines are supplied with a double system of piping, one working in conjunction with the turret-slide and the other with the cut-off. On the smaller machines, where a smaller amount of coolant is required, only a single system of piping is used.

URBAN BENCH LATHE

The Urban Machine & Tool Co., 2424-2430 St. Clair Ave., Cleveland, Ohio, has recently developed a screw-cutting bench lathe of quite unusual design. This machine is direct motor-driven with the spindle running in ball bearings, and due to the unusual method of mounting the carriage it is said to possess capacity for taking an exceptionally heavy cut without chatter. A machine of this type is said to be suitable for use in tool-rooms, experimental departments, laboratories, and on general commercial work, as it is adapted for handling from the lightest to the heaviest jobs that come within its range. From the accompanying illustrations the reader will at once notice the way in which a rather unusual application of direct-connected electric motor drive eliminates the need of using a belt, pulleys, or countershaft. A massive housing encloses all moving parts, including the motor which is built into the headstock. The gears are made of a special alloy steel, heat-treated to give the desired physical properties. They run submerged in oil, so that wear is reduced to a minimum. The bearings are of a radial thrust type, totally eliminating end play of the spindle which is made of 60-point carbon steel, heat-treated and ground to size.

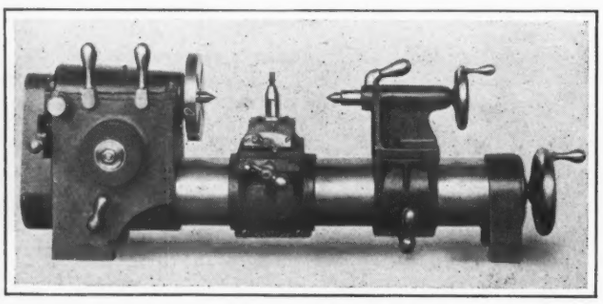


Fig. 1. Screw-cutting Bench Lathe Built by the Urban Machine & Tool Co.

One of the more unusual features of the design of this machine is its cylindrical bed, which is ground exactly to size and provided with a hardened and ground take-up gib. It will be seen that the tailstock completely embraces the bed, thus assuring a means of rigid clamping and allowing the tailstock to be set over to provide for the performance of taper-turning operations. Similarly, the carriage is ground to embrace the bed, and this method of support provides an unusually large bearing surface, which is said to eliminate chatter, and reduces wear to a minimum. A compound rest is provided which may be set at any desired angle; and longitudinal movement of the carriage is easily controlled and can be stopped instantly by throwing out a clutch lever on the headstock.

By placing the lead-screw inside the bed, it is thoroughly protected from chips and dirt. Provision is made for quickly detaching and easily changing gears to provide for cutting any standard threads from 8 to 64 per inch, including the 11½ pipe thread, and also for obtaining any desired rate of feed. The motor is furnished with a cord for connection to a lighting socket, which makes the machine very easy to set up. This arrangement also makes the machine portable as it only weighs 200 pounds, and no overhead works are required for driving. This machine swings 8 inches over the bed and 5¾ inches over the carriage. The capacity between centers is 12 inches. Either an alternating- or direct-current motor can be furnished, and there are five selective speeds of 125, 250, 400, 650, and 1000 revolutions per minute, with a reverse speed of 300 revolutions per minute.

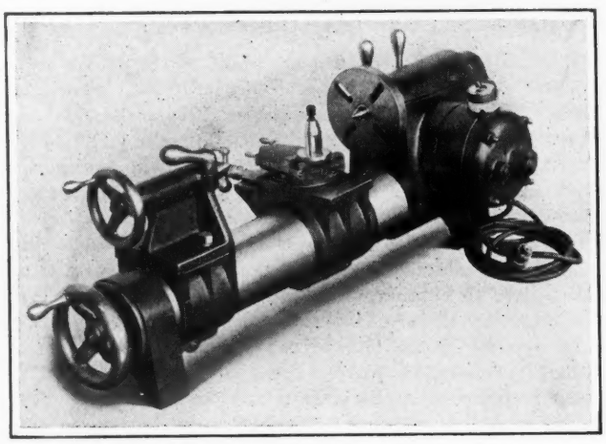


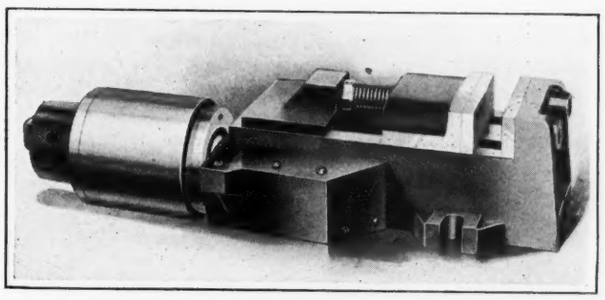
Fig. 2. Opposite Side of the Urban Bench Lathe, showing Direct-connected Motor Drive

AMERICAN PNEUMATIC MILLING VISE

For use in holding work during the performance of milling operations, the American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill., has recently developed a vise which can be either operated by compressed air or by hand. It is of the same width, depth, and opening of the jaws as the regular hand-operated milling machine vises, and is made so that it may be placed either crosswise or lengthwise on the milling machine table. No parts extend above the jaws which hold the work, so that the milling cutters can pass over the entire vise without interference. The design is somewhat similar to that of a standard hand-operated milling vise, as the jaws and screw-slide are the same, and the body has the usual tongues and slots for the guides. By

making the vise body from a steel casting, ample strength and rigidity are assured and the vise is made capable of withstanding the usual severe service encountered by such tools when operated in the average machine shop. The adjusting screw slide is built into the body and is practically an integral part. It is claimed that one of the valuable features of this vise is that after a piece of work has been gripped by the jaws the air supply may be entirely shut off, thus effecting a considerable saving in the amount of air that is consumed and still assuring the work being held securely in position until the machining operation has been completed.

A considerable amount of power is required to hold a piece of work between the jaws of a vise, and realizing this fact, the manufacturer has provided this vise with an air cylinder 4 inches in diameter. With an air pressure of 80 pounds per square inch on the piston, it will be evident that about 1,000 pounds initial pressure is available; and by means of a toggle mechanism this initial pressure is multiplied more than thirty times. Allowing for friction losses, etc., the final gripping power applied to the jaws should be in excess of 25,000 pounds. Although the vise is capable of exerting this enormous pressure, the jaws can be so adjusted that it will hold the most delicate pieces of work without damaging them. The air cylinder is double-acting to provide for opening and closing the jaws, and the action can be made practically instantaneous or it may be so regulated that the jaw travels very slowly toward the work. The air valve is mounted directly on the cylinder, and only one hose con-



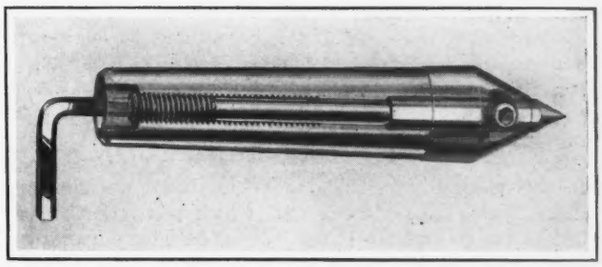
Air-operated Milling Vise Made by the American Pneumatic Chuck Company

nection is required. By merely moving a small handle, which can be done with practically no effort, the work can be clamped with such an enormous gripping power that it would be impossible to tighten it any further by means of a screw. The automatic action ranges from 0 to ¾ inch. Standard jaws furnished for use on this vise are plain, but special jaws may be made to meet the requirements of any specified job. Air-operated vises of this kind are made in four sizes known as Nos. 1 to 4, respectively, and having jaws 4, 5, 6, and 7½ inches in length.

ROBINSON ADJUSTABLE LATHE CENTER

The accompanying illustration shows an adjustable-point lathe center which is now being manufactured by the Robinson Adjustable Center Co., 1310 Twelfth St., Detroit, Mich. It is claimed that this new center will eliminate the waste of time and material caused by the necessity of frequently grinding lathe centers. The device is quite simple, consisting of four parts, namely, the body, center point, adjusting screw, and locking screw. The body is made of carbon steel, but the center point is high-speed steel, drawn just enough to relieve the strain of hardening. By holding all important dimensions within close limits of tolerance, the parts of this device are made interchangeable.

Not only does the high-speed steel point give from seven to nine times more service per grind than does an ordinary carbon steel center, but when it does become necessary to



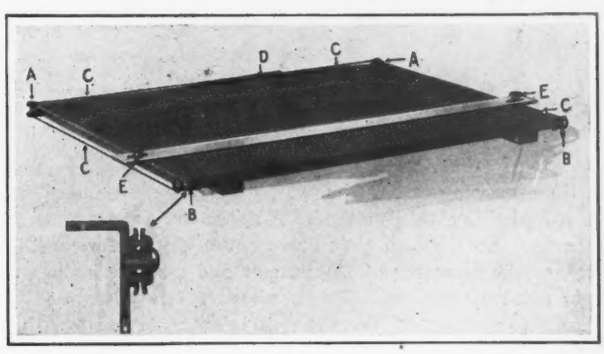
Lathe Center with Adjustable Point, Made by the Robinson Adjustable Center Co.

grind a new point there is a much shorter angle to be ground and a much heavier feed can be used, as the high-speed steel will withstand a greater friction heat than the carbon steel without its temper being drawn. This makes it possible to reduce the time of the grinding operation from the usual fifteen or twenty minutes to one to two minutes. As the point is gradually worn down, it is adjusted with the regulating screw, without having to shift the tailstock, and when finally worn out, only the small center point needs to be replaced, instead of scrapping the entire center. This adjustable center can be used in either the tailstock or the spindle of a lathe or grinding machine, and no job is too heavy for it.

ECONOMY PARALLEL RULER ATTACHMENT

An improved parallel ruler attachment for use on drawing-boards, which has recently been developed by the Economy Drawing Table & Mfg. Co., Adrian, Mich., consists of a set of two ball-bearing double pulleys *A* attached to the back corners of the board and two single ball-bearing pulleys *B* attached to the front corners. A wire cord *C* is placed around these pulleys, making a double lap around each end and at the back of the board; but there is no wire across the front. By crossing the wire at the back, the upper laps at both ends move forward or backward simultaneously. The ends of the wire are joined at the back through a steel spring *D*, and both ends of the straightedge are attached to the upper wire at the ends of the board by means of binding posts *E*, thus making it impossible to move one end of the straightedge without moving the other a corresponding amount in the same direction.

It will be obvious that the use of an attachment of this kind does away with the need of watching the head of an ordinary T-square, to make sure that it is always firmly against the edge of the drawing-board; and as a result, the draftsman using one of these attachments is able to work more rapidly than would otherwise be possible. Perfect accuracy is obtained because opposite ends of the straightedge are attached to the same wire and movement of one end of the straightedge can only be accomplished by a corresponding movement of the opposite end in the same direction. The straightedge will not slide off the board when it is in-



Parallel Ruler Attachment Made by the Economy Drawing Table & Mfg. Co.

clined, and it is possible to lift the straightedge clear of the board when changing drawings, without loosening any thumb-nuts. This straightedge can be set at any angle across the board, if so desired.

LOVEJOY RIGHT-HAND TOOL

In the accompanying illustration is shown a right-hand turning, facing, and planing tool, which has recently been added to the line of positively located inserted-cutter tools made by the Lovejoy Tool Co., Inc., Springfield, Vt. It will be seen that this tool is made without any projections that are likely to catch the workman's clothes or interfere with the work or machine on which it is used. A tool of this kind is especially adapted for operation on a machine that does not conveniently permit of the removal of the tools from the front side of the carriage, or where clustering is necessary, with no overhang. This tool is liberally proportioned, having a shank measuring 1⅛ by 1⅛ inches, and a

Right-hand Turning, Facing and Planing Tool-holder Made by the Lovejoy Tool Co., Inc.

¾-inch high-speed steel cutter that is mounted in the holder at such an angle that very little or no grinding is required except on the end. The tool is pushed forward to compensate for wear. By slightly modifying the end of the cutter, this tool is converted into an efficient and serviceable planer tool. It can be used for all ordinary jobs for which a solid forged tool of this size can be employed, and a saving of high-priced steel is effected through the substitution of an inserted cutter for a solid tool.

H. H. ARNOLD REAMERS AND COUNTERBORES

To reduce the cost of high-speed steel reamers, the H. H. Arnold Co., Rockland, Mass., has recently developed a method of manufacture by which high-speed steel blades are held in machine steel bodies by staking them in place. With reamer blades, the area of contact is so large in proportion

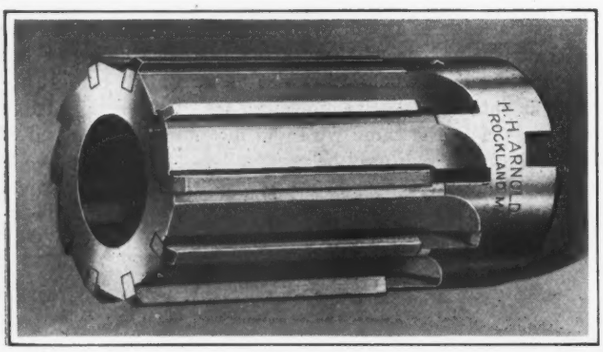


Fig. 1. Shell Reamer Made by the H. H. Arnold Co. with Inserted High-speed Steel Blades

to the pressure exerted, that ample holding power is said to be afforded by this method. Adjustment is provided by tapering the slots so that driving the blades forward increases the diameter of the reamer and maintains the cutting point at the end. The purpose of this adjustment is merely to compensate for wear; it is not practical to adjust for one or two over-size holes and then back to size. Driving the blades out and regrinding after they are worn down

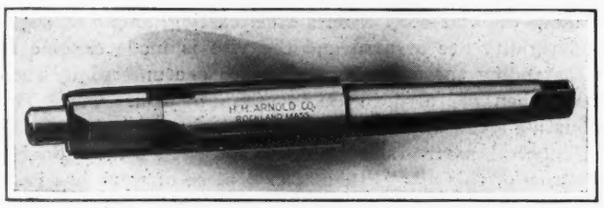


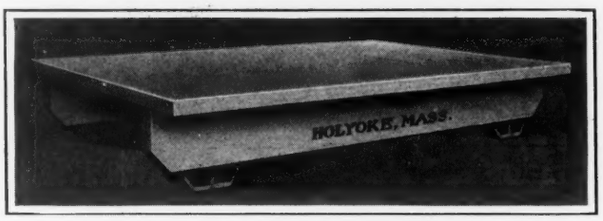
Fig. 2. Counterbore Made by the H. H. Arnold Co. with Inserted High-speed Steel Blades

below the specified limits of accuracy may be repeated several times and greatly increases the life of the tool.

Counterbores are made by this company, using the same general method of supporting high-speed steel blades in machine steel bodies; but in the case of counterbores, the blades are secured in place by brazing, in a manner similar to that employed in the case of milling cutters of this company's manufacture which were described in the July number of MACHINERY. On the counterbores, the pilots are interchangeable and they are hardened and ground and held in straight holes by means of set-screws. These counterbores are made in standard sizes from ¾ inch to 2⅝ inches outside diameter, and three standard shank sizes cover the entire range. The pilot sizes range from 7/16 inch up, and all stock sizes are made with Morse taper shanks.

COWAN METAL FEET FOR TRANSVEYOR SKIDS

To provide for increasing the length of service obtained from wooden skids used with elevating trucks or so-called "transveyors", the Cowan Truck Co., 16 Water St., Holyoke, Mass., is now manufacturing metal feet of the form shown in place on a skid which is illustrated in connection with this description. These feet are made of cast iron and

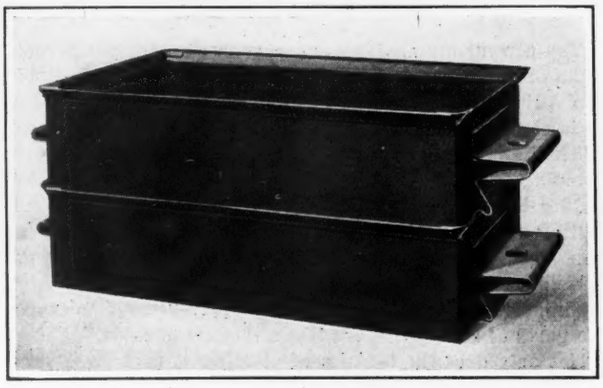


Metal Feet Made by the Cowan Truck Co. for Use on Transveyor Skids

bolted in place on the skid. They take the wear to which the wooden supporting surfaces would otherwise be subjected and are said to more than double the life of a skid on which they are used.

E. F. HAUSERMAN TOTE-BOX

To meet the requirements of manufacturing plants which have large quantities of small parts to be handled and stored, the E. F. Hauserman Co., Cleveland, Ohio, has re-



Steel Tote-box manufactured by the E. F. Hauserman Co.

cently developed an improved steel tote-box. It is claimed that the design has been worked out along such lines that boxes of this type are "pinch proof" in handling, and they may be stacked together to effect the maximum economy of floor space. These features are secured through the application of a special form of handles, and by the construction which is such that the top of each box cannot become distorted. At the upper edge, the metal on the sides and ends is folded back on the under sides and welded, and the insides of the upper corners are reinforced with electrically welded plates made of 14-gage steel. The handles are large and broad, assuring easy handling, and no edges of metal are left above the handles in a way which will allow them to become loose and constitute a constant danger of cutting the workman's hands. Two heavy 1-inch steel runners are welded to the bottom for the full length, and add greatly to the amount of service obtained from a box.

ELWELL-PARKER ELECTRIC SHELL TRUCK

The movement of shells of the larger sizes, when a crane is not available, has proved quite a problem. To provide for handling them without damage to the finished surface or copper bands necessitated developing a special equipment for arsenal use. The Elwell-Parker Electric Co., Cleveland, Ohio, has recently placed an equipment on the market which makes this work comparatively easy. Large shells weigh from ½ ton to 1½ tons, and when first landed by crane they are laid on 4- by 4-inch timbers on the floor. The electric ammunition truck approaches from the base end, and a special leather-lined hand-clamped belt is placed

Truck Built by the Elwell-Parker Electric Co. for Picking up and Carrying Large Shells

about the shell. Then the cables are payed out until the eyes in the lift-bars may be dropped over the clamp trunnions. The operator now closes an electric switch which starts the special Elwell-Parker low-voltage hoist motor that takes current from a storage battery. As the two cables are wound in, the shell is rocked into a vertical position and then lifted a few inches off the ground. At this point the cable sheaves strike the overhanging crane structure at the top. The whole crane frame is pivoted on the truck trailing axle, and as the drum continues to wind in the cables, the whole crane frame lined with wood blocks rocks with the shell backward over the axle, and is supported by the combined action of tension on the cables and the special spring buffers on each side. At a predetermined point, the hoist motor is stopped by an automatic tripping device actuated by the rocking crane. The shell is carried in this position. Exactly the reverse operation takes place in setting the shell down.

NEW MACHINERY AND TOOLS NOTES

Slide-rule: Knief & Co., 4168 W. 25th St., Chicago, Ill. A standard Mannheim slide-rule with a metal body made of nickel silver to which the graduated white celluloid facings are glued. The body or frame of the rule is die-cast.

Transformer: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. An improved line of distribution transformers which are so constructed that a reduction of weight exceeding 33 per cent is made possible. This is largely the result of substituting a welded sheet-steel case in place of one made of cast iron. These transformers are known as the "Steel-clad Type S."

Portable Kerosene Furnace: Champion Kerosene-Burner Co., Kenton, Ohio. A portable kerosene burning furnace which is adapted for use in heating rivets, tools and other work of a similar nature. It is a self-contained unit with the fuel tank carried by a lower platform of the stand. The tanks are made in various sizes, depending on the service required of the furnace.

Back-geared Engine Lathe: Rockford Lathe & Drill Co., Rockford, Ill. An "Economy" 14-inch double-back-geared, quick-change engine lathe which has been redesigned to meet the demand for a small heavy-duty machine having sufficient power for use in the production departments of progressive manufacturing plants where the work involves operation under high speeds and heavy feeds.

Face Masks: Julius King Optical Co., 10-12 Maiden Lane, New York City. A face mask designed to afford protection for men using autogenous cutting and welding torches. These masks are made of fiber and there is provision for a free circulation of air between the mask and the workman's face, which not only keeps him cool, but avoids tendency of the lenses to become fogged.

Abrasive Wheels: Wolf New Process Co., 711 Hanover St., Meriden, Conn. Abrasive wheels made by a process which is claimed to enable them to have a free cutting action. Any desired abrasive may be used in making these wheels, as the special process only concerns the bonding material. Wheels of this kind are made in any size or shape within the limits of present commercial standards.

Improved Features of Planer Construction: Cincinnati Planer Co., Cincinnati, Ohio. This company has recently made a number of noteworthy improvements in the construction of planers of its manufacture, which include the introduction of such features as forced lubrication, a box type of construction for the bed and table, the use of herringbone gears, and the provision of rapid-power traverse.

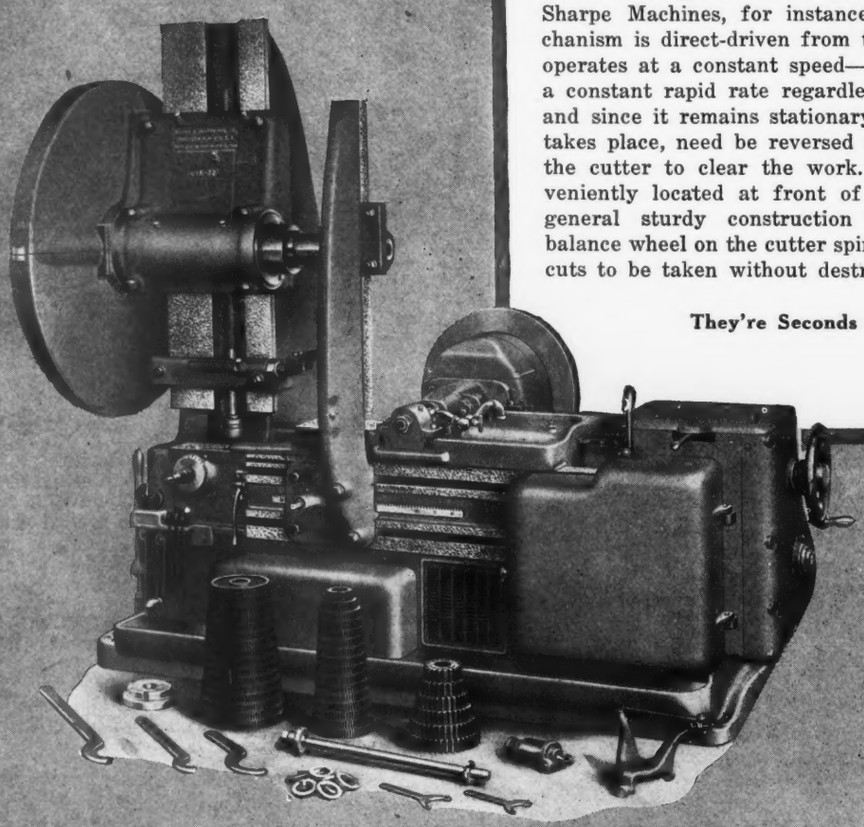
Unit Jacks and Bolt Couplers: Roberts Mfg. Co., 152 Brewery St., New Haven, Conn. For use in setting up and facing work in position on drilling, slotting, and planing machines, this company has developed a line of unit jacks and bolt couplers. This equipment takes the place of a miscellaneous assortment of clamps and blocks commonly used for the purpose, and reduces the time required for setting up work.

Automatic Water Heater: Bridgeport Machine & Tool Mfg. Co., Bridgeport, Conn. An automatically operated electrical water heater which provides for the delivery of hot water by simply turning the faucet. The result in this respect is the same as that produced by an automatic gas heater. This device is known as the "Ever Hot" water heater and is adapted for providing hot water in the washrooms of industrial plants, etc.

Horizontal and Vertical Milling Machines: Cincinnati Milling Machine Co., Cincinnati, Ohio. A Type M milling machine which is of similar design to the plain 18-inch manufacturing miller and the No. 5 high-power miller of this company's manufacture. The new Type M milling machine is made in Nos. 1 and 2 sizes and in three styles, namely, plain, universal, and vertical. All of these new machines are of the constant-speed type.

Cabinet Truck for Welding and Cutting Apparatus: Davis-Bournonville Co., Jersey City, N. J. This cabinet truck provides a convenient means of transporting oxy-acetylene welding and cutting equipments which can be used direct from the truck. An upright steel cabinet body is mounted on wheels, and there is a platform to support an oxygen and either a hydrogen or an acetylene cylinder, the cylinders being held in place by chains.

Make the *Seconds* Work



Time saving features are numerous on Brown & Sharpe Machines, for instance: the indexing mechanism is direct-driven from the drive pulley and operates at a constant speed—the slide returns at a constant rapid rate regardless of feed or speed and since it remains stationary while the indexing takes place, need be reversed only far enough for the cutter to clear the work. Controls are conveniently located at front of the machine. The general sturdy construction together with the balance wheel on the cutter spindle allow fast heavy cuts to be taken without destructive chatter.

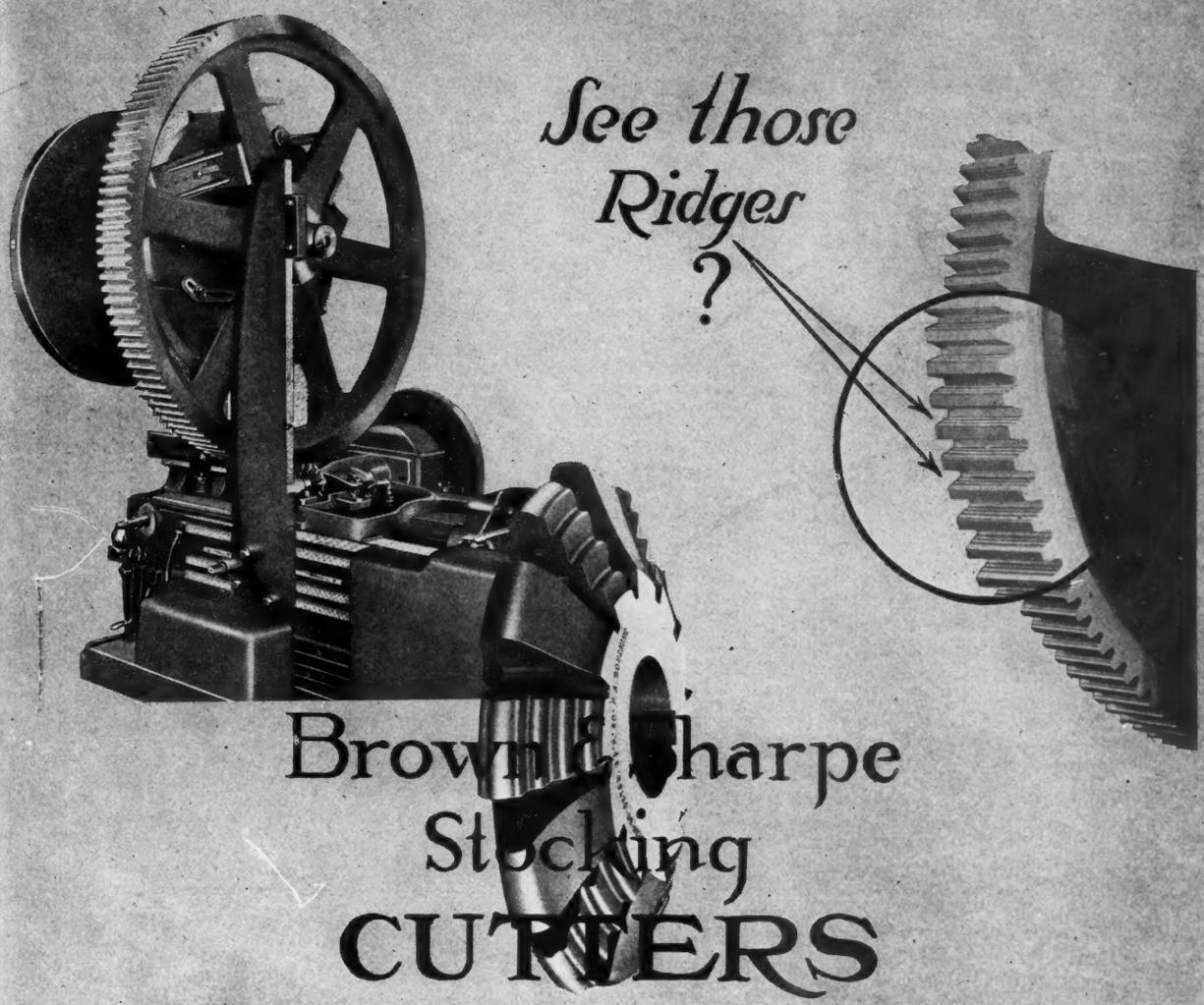
They're Seconds Savers

B·S TRADE MARK

CAPACITY
Spur gears to 72″ diameter, 13″ face. Cast iron, 1¾ diametral pitch; steel, 2 diametral pitch.

BROWN & SHARPE
Automatic
Gear Cutting Machines
BROWN AND SHARPE
Providence

The Hours Care for Themselves



Brown & Sharpe Stocking CUTTERS

As shown by the photos very little stock remains to be removed by the finishing cutter and being in a series of ridges or steps, presents the minimum of resistance to the cutter.

The greater part of the cutting action is performed by the plain teeth, the stepped teeth projecting beyond them only enough to break up the chips. This permits the taking of heavy cuts at fast speeds and coarse feeds.

Results: Greatly increased production, longer life for the cutters and a considerable saving in time otherwise spent in changing and sharpening cutters.

MANUFACTURING CO.,
Rhode Island.

Sterilizing Cutting Oils by Pasteurization and Centrifugal Separation

OPERATORS of automatic screw machines, gear-cutting machines, and other types of machine tools on which it is necessary to keep the cutters and work flooded with oil or one of the soluble oil cutting emulsions, have experienced trouble through the development of various forms of skin disease which are known under the general name of "compound poisoning." In some plants, this trouble has assumed such serious proportions that large sums of money have been spent in conducting investigations, with the idea of definitely ascertaining the cause of these eruptions which develop on the hands and arms of machine operators, and of removing the cause of infection.

Despite these efforts which have been made, there still seems to be no definite agreement as to the exact nature of the skin diseases caused by cutting oils, although they are quite generally attributed to the presence of bacteria in the oil. Not only are there a variety of opinions concerning the cause of the disease called compound poisoning, but there are also a number of different methods by which an attempt has been made to remove all bacteria and other foreign matter from the oil, that is likely to be responsible for the trouble.

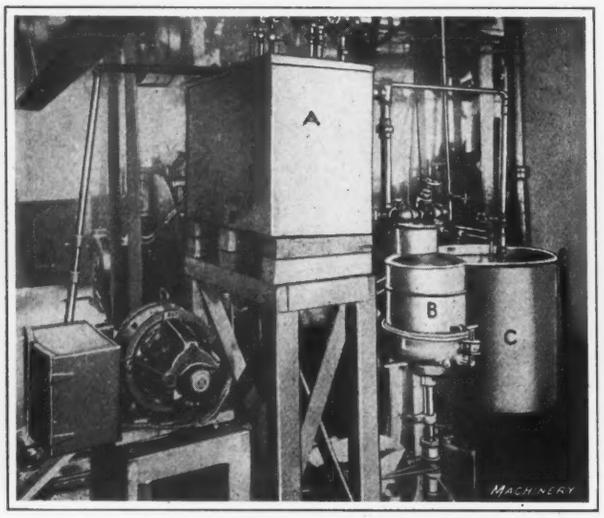


Fig. 1. Original Plant installed in Ford Factory for Cleansing Cutting Oils by Pasteurization and Filtration

A Departure from Established Practice in Sterilization

Two general methods have been employed for the removal of bacteria from oils and cutting compounds: First by the addition of a germicide such as carbolic acid or creosote to the oil; and second, through employing a process of sterilization by heating the oil. But neither of these methods has been developed to a point where definite assurance may be given that oil so treated will not cause cases of skin disease among operators of machines on which the oil is used. An interesting discovery of the assistance given by a centrifugal separator in helping to remove bacteria from oil was made by James W. Ramsdell, in connection with his inspection of working conditions at the plant of the Ford Motor Co. in Detroit, Mich. After trying various methods for the purification of coolants used on metal-cutting tools in this factory, a practice was finally adopted of first subjecting the oil to pasteurization in an equipment so arranged that the fluid could be raised to any temperature up to 212 degrees F. After receiving this treatment, and before the oil was allowed sufficient time to cool, it was removed from the pasteurizing apparatus and placed in a centrifugal cream separator, with the idea of removing suspended foreign matter. Centrifugal separation of the hot oil was more effective than where it was treated at a normal temperature, because the hot oil is less viscous. Tests were made of the number of bacteria present in the oil before and after receiving this centrifugal treatment, and it was found that the oil passed through the separator was free from bacteria, while samples taken after the process of pasteurization were still quite heavily contaminated. This fact has been definitely determined, although the way in which the bacteria are removed is still a matter of hypothesis. It is suggested that the bacteria may gather into groups possessing sufficient weight so that centrifugal force is able to act upon them.

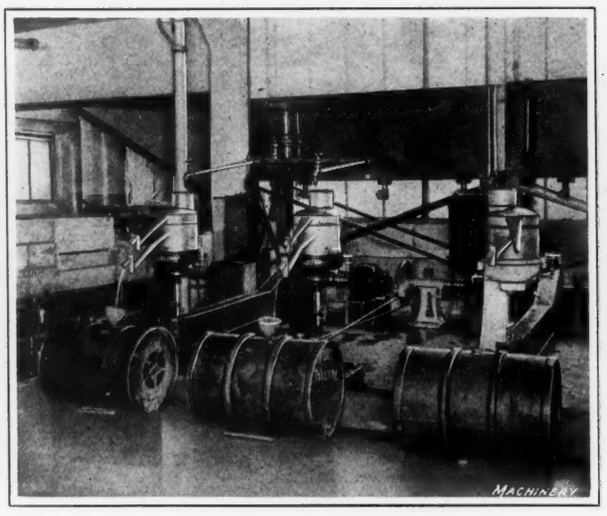


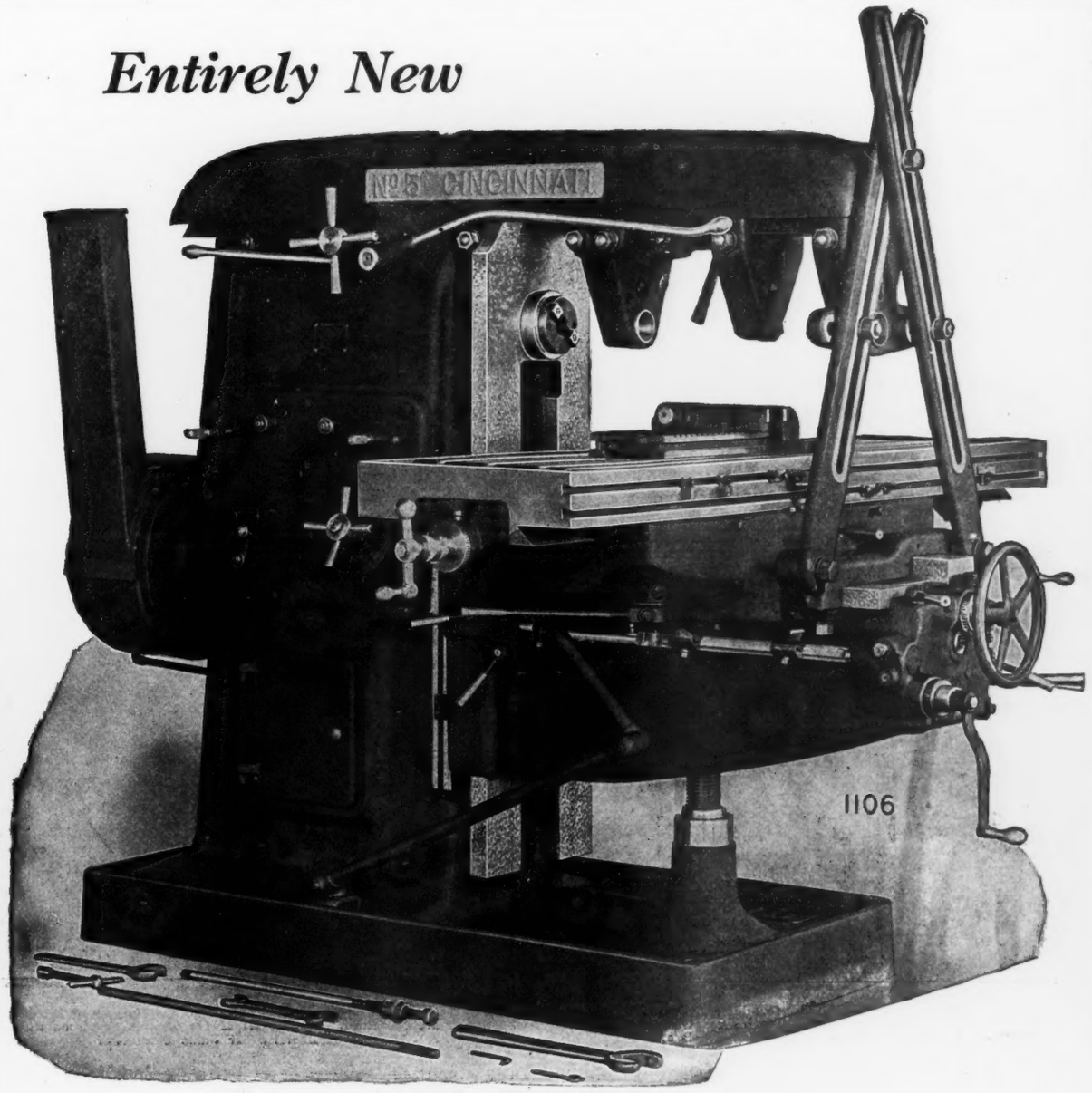
Fig 2. Oil Cleansing Plant of Improved Design, which operates on the Same General Principle as that shown in Fig. 1

Mr. Ramsdell has also reached the conclusion that cases of compound poisoning which develop among machine operators are not due solely to the presence of bacteria in the oil, although these are an important factor. It is his belief that there are two other contributory causes, namely, a poor physical condition of the operator, and the tendency of hydrocarbon oils to dissolve fats from the skin. Removal of the fatty matter from the skin leaves it dry and liable to crack; and then the bacteria in the oil find their way through these abrasions and, assisted by the poor physical condition of the operator, they are able to cause localized blood-poisoning.

Method Developed for the Treatment of Oils and Cutting Compounds

Fig. 1 shows the first experimental plant which was installed at the Ford Motor Co.'s plant, for applying a combination of the principles of pasteurization and filtration for cleansing oil. Sixteen gear-cutting machines which are partially shown in the background of this illustration were supplied with cleansed and sterilized oil, treated in this purification plant. The results obtained from the gear-cutting machines demonstrated that not only were the operators kept free from infection, but that a better grade of workmanship could also be produced; and the average production obtained from each of the rotary gear-cutting tools be-

Entirely New



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Feed changes at front of machine, by one lever, while running

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fore grinding became necessary, was forty more gears with the purified oil than where dirty oil was employed.

In Fig. 1, the pasteurizer is shown at *A*. This part of the apparatus was equipped with steam coils capable of raising the temperature of the oil as high as 212 degrees. From the pasteurizer, the oil is discharged into a DeLaval centrifugal cream separator shown at *B*, which not only removes suspended foreign matter from the oil, but also has a tendency to remove bacteria in the manner previously described. After passing through separator *B*, the oil is delivered to a cooling tank *C*, in which its temperature is reduced to normal, after which the oil is ready to be returned to the gear-cutting machines for subsequent use.

One of the chief reasons why the oil is able to give so much better service after being treated in this way, is that all particles of metal have been removed, so that their abrasive action on the edge of the cutting tool is eliminated. Some authorities claim that the removal of such impurities is also a factor in improving sanitary conditions, because the metal particles are believed to have a tendency to abrade the skin and cause openings, which either admit bacteria or allow the irritating properties of the oil to become effective in causing sores to form on the machine operator's hands and arms.

Fig. 2 shows a better organized oil cleansing plant that is now used at the Ford factory. In the background of this illustration there will be seen an elevated tank to which the dirty oil is returned and subjected to a temperature suitable for pasteurization, by means of steam coils provided in the tank for that purpose. The oil can be drawn off by gravity into the centrifugal separators which are mounted at a level midway between the bottom of the pasteurizing tank and the floor. The equipment shown in this illustration had not been completed at the time that the photograph was taken. In the illustration the oil is shown flowing from the centrifugal separators into funnels placed in steel barrels that receive the clean oil; but it is the intention to have this clean oil delivered into a cooling tank, from which it will be pumped back through piping to the various machines on which the oil is used. There seems to be no limit to the possibility of rejuvenating oil. By this process of sterilization and filtration, the oil is said to be brought back to 100 per cent efficiency after each treatment, so that the expense of lubricating or cutting oils is reduced to the cost of labor for operating the cleansing plant plus the value of the slight amount of oil which is lost by spattering on the floor, etc. The saving made possible at the plant of the Ford Motor Co. by treating cutting oils and compounds in this way, is estimated at from $200 to $300 a day, in addition to a substantial improvement in the quality of the work.

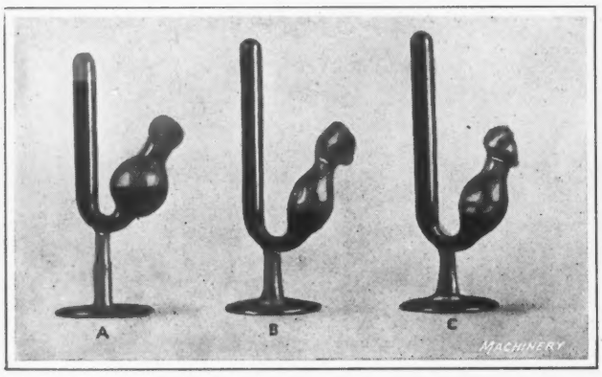


Fig. 3. Three Fermentation Tubes used for determining Presence of Bacteria in Cutting Oils. Untreated Oil at A contains Bacteria; there are no Bacteria in the Treated Samples B and C

Testing Oil to Ascertain Its Freedom from Bacteria

Those who have any knowledge of bacteriology know that one of the causes of a case of infection that arises through the presence of bacteria in the system is the extreme rapidity with which many of the disease-producing species of bacteria increase. As a case in point, let us consider what happens if a dangerous form of germ finds its way into an abrasion on the skin of a workman's hand. In a very short time, this single germ may have developed into an incredibly large number of bacteria which are able to cause a bad case of compound poisoning.

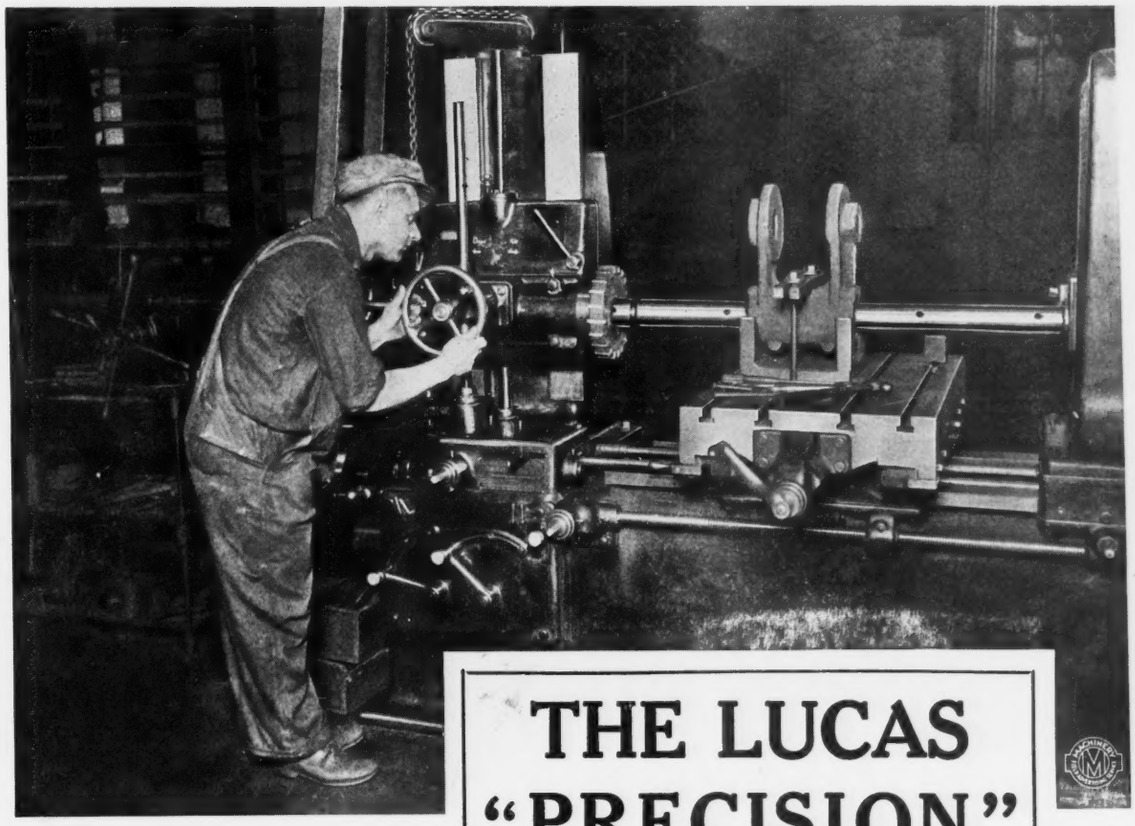
This tendency for bacteria to increase rapidly under favorable conditions is utilized by bacteriologists in determining the presence of bacteria in cutting oil, or in other substances under test, or the freedom of the oil from bacteria. The method of procedure is to make what is known as a "culture," which is simply a medium that is favorable to the growth of bacteria. Many different kinds of cultures are used, among which mention may be made of ox bile sweetened with lactose. Fig. 3 shows three fermentation tubes that are used in the present instance for determining the presence of a form of bacteria in the oil which has the tendency to produce fermentation when placed in a lactose-bile culture; and its presence is made evident in a culture contained in a fermentation tube by the presence of gas, which results from fermentation of the culture in the closed end of the tube. At *A*, Fig. 3, there is shown a culture in which this form of bacteria is present, while at *B*, no gas has formed in the fermentation tube, and so it is reasonable to assume that this culture has not developed any of the bacteria for which the test was made.

In making a culture, great care must be taken to have the fermentation tube or other vessel in which it is placed, carefully sterilized, so that it is perfectly free from bacteria. The culture medium is then placed in the container, and a test for the presence of bacteria in the oil is conducted by dipping a sterilized platinum wire into the oil to bring out a single drop of the oil, which is put in the culture. After this has been done, the culture is placed in an incubator, where the temperature is maintained at a degree most favorable for the development of the type of bacteria for which the test is being made. At *A*, Fig. 3, there is shown a culture which was inoculated with unpasteurized oil, and the culture at *B* was inoculated with pasteurized oil. As gas is developed in the fermentation tube *A*, and no gas in the tube at *B*, it can be assumed that all of the bacteria that were present in the uncleansed oil were eliminated by the treatment to which it was subjected.

Fig. 4. Method of testing Oil to determine the Number of Bacteria which are contained. The Result of the Test is expressed as a Number of Bacteria per Cubic Centimeter

Determining the Number of Bacteria Present in Oil

Determinations of the number of bacteria which are present in an oil or any other fluid under test, are usually expressed in a specified number of bacteria per cubic centimeter of the fluid. Determinations of this kind are made by a process known as "plating out." For this purpose, a gelatin culture is made in a sterilized dish of the form shown in Fig. 4. Each of these dishes is provided with a close-fitting cover, which excludes air and avoids the possibility of bacteria carried by air finding their way into the culture. When the cultures have been prepared, the oil to be tested is placed in a pipette, which is graduated to provide for delivering



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When photographed, this machine was boring a hole 4½" in diameter in an iron casting 10" long intended for use in the Universal Milling Attachment for the No. 3-B Hendey Miller.

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exactly one cubic centimeter of oil into each culture; and care is taken to see that the oil is uniformly distributed over the entire surface of the gelatin.

By leaving the culture in an incubator for a period of twenty-four hours, any bacteria carried by the oil are given an opportunity to develop, each individual germ producing a colony which can be readily seen on the surface of the gelatin. In Fig. 4, it will be evident that the surface of the gelatin in the right-hand dish is covered with white spots, each of which is a colony of bacteria that has developed from a single germ which was deposited on the gelatin from the one cubic centimeter of oil placed in the dish. The bacteriologist counts these colonies which have developed on the gelatin, and this number represents the bacteria per cubic centimeter that were in the oil at the time the test sample was taken. The dish at the left-hand side has no bacteria present in it. E. K. H.

* * *

CRANK-HANDLE DRILLING FIXTURE

Various sizes of cast-iron crank-handles are required for use on the line of gasoline-measuring pumps and similar garage equipments which are manufactured by S. F. Bowser & Co., Inc., of Fort Wayne, Ind. Extreme accuracy is not necessary in making these parts, but it is of importance to

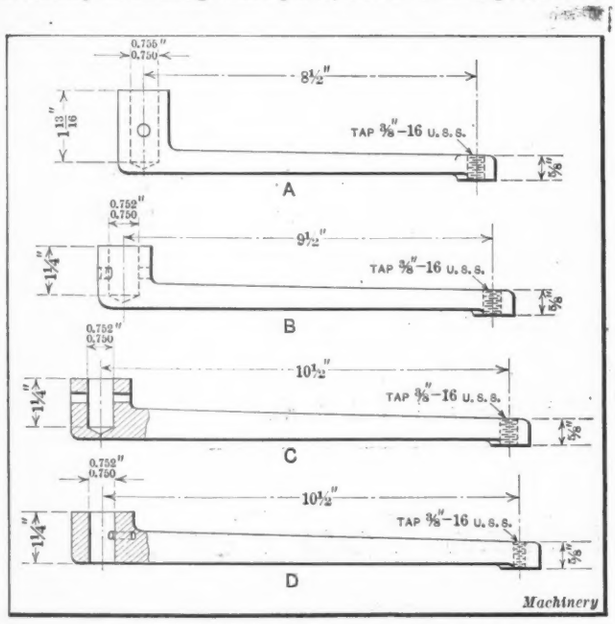

Fig. 1. Four Sizes of Crank Handles to be drilled

reduce production costs in machining them just as far as possible. With this idea in mind, a multiple indexing drill jig was developed, which is adapted for drilling and reaming the holes in opposite ends of these crank-handles. Either four or five handles are drilled and reamed simultaneously on a multiple-spindle drilling machine equipped with one of these jigs, the number of pieces drilled at a time being dependent upon the size of the crank-handles that are to be machined.

Fig. 1 shows four different styles of crank-handles which are drilled and reamed in the indexing jig illustrated in Fig. 2. It will be seen that these handles are 8½, 9½, and 10½ inches in length, respectively. To adapt the same jig for holding pieces of these different sizes, use is made of the three different filler blocks shown in Fig. 3, which are marked *A*, *B*, and *C* and *D*, to coincide with the marking of the corresponding sizes of crank-handles shown in Fig. 1. It will be evident that these filler blocks are of the same design, except that block *A*, which is adapted for holding the 8½-inch handles, is made to project 2 inches further out from the center of rotation of the jig than the filler block marked *C* and *D*, which holds the two longest handles. Block *B* is an intermediate size.

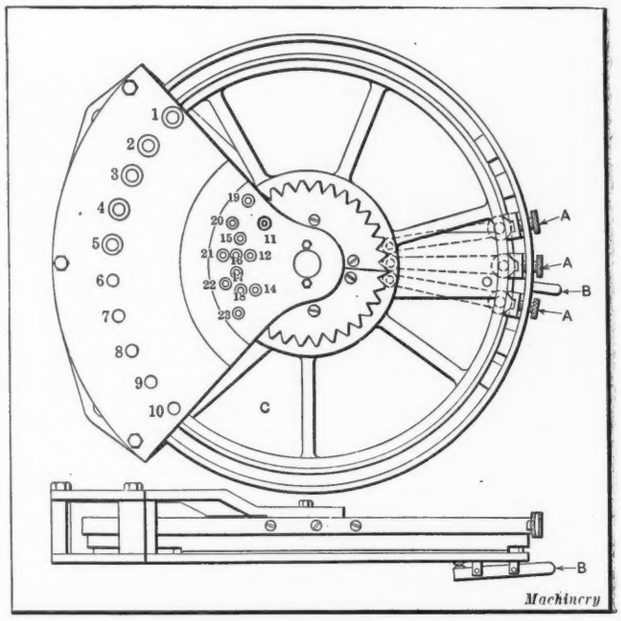

Fig. 2. Indexing Jig designed to drill and ream Four Sizes of Handles

For performing drilling and reaming operations in this indexing jig, thirty-five, twenty-eight, or twenty-one crank-handles are set up, according to their size, these pieces being held at their inner end by means of V-notches in the filler blocks and at their outer end by means of knurled-head cap-screws *A*. The reason for drilling smaller numbers of the longer handles at a time, is that the inner ends of these handles come so close to the center of the jig, that it would be impossible to set up thirty-five of them in position for drilling. This is why only twenty-one of the 10½-inch handles or twenty-eight of the 9½-inch handles can be set up; but 75 per cent of the handles drilled are 8½ inches long, and for that reason it was not felt desirable to make a jig large enough to enable thirty-five of the medium and largest sized handles to be set up at a time.

Reference to Fig. 1 will show that three of the types of crank-handles to be machined have blind holes at their large end, although handle *D* has the ¾-inch hole going all of the way through. It will be evident that after ¾-inch holes have been drilled in handles *A*, *B*, and *C*, these blind holes act as cups which retain the chips. Obviously it will be impossible to ream these holes with the chips in them, because a reamer often has difficulty in clearing its

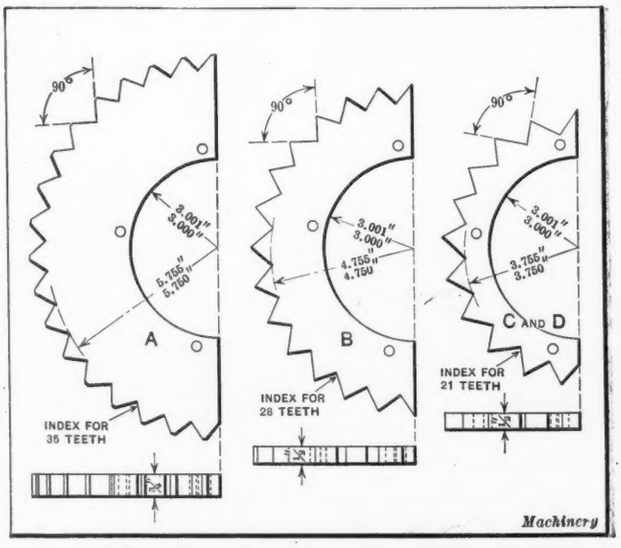

Fig. 3. Filler Blocks used on Jig shown in Fig. 2, to locate Different Sizes of Handles

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own chips, without being hampered by the presence of a lot of coarse drill chips. To overcome trouble which would be experienced if the drill chips were left in the holes, the jig was designed to carry an odd number of groups of castings to be drilled, that is to say, seven groups, respectively, of five 8½-inch handles, four 9½-inch handles and three 10½-inch handles. In operation, the jig carrying the handles with blind holes is indexed through a number of spaces equal to twice the number of castings that are drilled in a group, thus bringing the handles that have just had the $\frac{21}{64}$-inch holes drilled in them, out to a position indicated at *C* in Fig. 2, so that they are clear of the reamers. While in this position, the operator takes an air hose and blows the chips out of the drilled holes; then he removes the pieces of work that have been both drilled and reamed, replaces these with a group of undrilled castings, and indexes the fixture to the next position.

Indexing of the fixture according to this method brings the castings that were drilled at the previous rotation of the jig under the reamers, while making their second trip around the circle. In this way the work is reamed and is ready to be removed from the fixture after it is indexed to bring the work clear of the plate in which the reamer holes are drilled. If there were not an odd number of groups of castings to be machined, the work would not come under the reamers at the second revolution of the jig. It will be evident that as many handles are drilled and reamed in a specified period of time by this method as would be the case if the fixture were only indexed through half as many spaces, the only difference being that the operator is required to blow away the chips after the holes have been drilled. No time is actually lost by having the work make two revolutions after it has been set up in the fixture. When this method of drilling was first employed, the removal of chips from the blind holes gave a great deal of trouble; but after the idea of using an odd number of groups of work, and of indexing the work through the number of spaces occupied by two groups of pieces was employed, this difficulty was effectually overcome.

For drilling crank-handles of the form shown at *A* in Fig. 1, the $\frac{21}{64}$-inch holes in five handles are drilled through bushings 1, 2, 3, 4, and 5, Fig. 2, while three $\frac{7}{16}$-inch holes are drilled at the same operation through bushings 19, 20, and 21. After this has been done, lever *B* is depressed in order to withdraw the locking pin, so that the jig may be indexed through successive intervals of ten spaces. When the jig has made a complete revolution, the next downward stroke of the drilling machine reams the drilled $\frac{21}{64}$-inch hole in each of the five handles to a diameter of ¾-inch, the reamers working through holes 6, 7, 8, 9, and 10. At the same time the $\frac{7}{16}$-inch holes in the two remaining crank-handles are drilled through bushings 22 and 23. The reason for drilling the smaller holes in two successive positions is to allow a space between the drill bushings greater than the minimum center distance on which the drilling machine spindles can be located.

For drilling the size of crank-handle shown at *B*, four castings can be drilled and reamed simultaneously. The four $\frac{21}{64}$-inch holes are drilled through bushings 1, 2, 3, and 4, and at the same time two of the $\frac{7}{16}$-inch holes are drilled through bushings 15 and 16. After this has been done, the jig is indexed through successive intervals of eight spaces; and on the next revolution of the jig the four $\frac{21}{64}$-inch holes are reamed to a diameter of ¾-inch through holes 6, 7, 8, and 9; and at the same time two $\frac{7}{16}$-inch holes in the opposite end of the other two handles are drilled through bushings 17 and 18. It will be apparent that in this case, one of the large drill bushings and one of the corresponding reamer holes are skipped.

For drilling the sizes of crank-handle shown at *C* and *D*, in Fig. 1, the method of procedure is essentially the same as for handle *B*. The three $\frac{21}{64}$-inch holes are drilled through bushings 1, 3, and 5, and two $\frac{7}{16}$-inch holes are drilled at the opposite ends of two handles, bushings 11 and 12 being used. Then the jig is indexed and after it has made a complete revolution, the work has advanced five spaces, so that the three $\frac{21}{64}$-inch holes can be reamed to a diameter of ¾ inch through holes 6, 8, and 10; and at the same time, the $\frac{7}{16}$-inch hole at the opposite end of the third handle is drilled through bushing 14. As in the preceding case, drill bushings 2 and 4 and reamer holes 7 and 9 are not used in this set-up.

Any of these four drilling and reaming operations is performed with the same jig set up on a cluster type of multiple-spindle drilling machine, on which at least fifteen spindles are available, so that while machining crank-handles of the type shown at *A*, the holes at both ends of five handles are drilled and reamed each time the fixture is indexed. As in the case of all indexing jigs or fixtures of this type, a high rate of production may be obtained, because the operator is able to remove finished pieces and substitute other castings in their places, while the drilling and reaming operations are being performed on castings at the opposite side of the jig. E. K. H.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly at New York, N. Y., for October 1, 1919.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the General Manager of The Industrial Press, Publishers of MACHINERY, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press	140-148 Lafayette St., New York
Editor, Erik Oberg	" " " " "
Managing Editor, None	
Business Managers:	
Alexander Luchars, President	" " " " "
Matthew J. O'Neill, Treasurer and General Manager	" " " " "

2. That the owners of 1 per cent or more of the total amount of stock are:

The Industrial Press	140-148 Lafayette St., New York
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Louis Pelletier	" " " " "
Erik Oberg	" " " " "
H. L. Ketchum	" " " " "
E. Y. Urban	" " " " "

3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 30th day of September, 1919.

(SEAL)

WILLIAM E. BACON,
Notary Public, New York County, No. 12.
New York Register, No. 10196.
(My commission expires March 30, 1920.)

PERSONALS

J. R. PEARSEN, formerly vice-president and general manager of the Acme Machine Tool Co. of Cincinnati, severed his connection with this concern November 1.

JAMES SPRING, former superintendent of the Independent Pneumatic Tool Co.'s Chicago plant, is now works manager of the Superior Motors Co., also of Chicago.

CAPTAIN JOSEPH R. GREENWOOD, having recently received his discharge from the Army, has renewed his association with the firm of Charles H. Higgins, architects and engineers, 19 W. 44th St., New York City.

CHARLES F. SCRIBNER, formerly industrial engineer with the Colt's Patent Fire Arms Mfg. Co., Hartford, Conn., and

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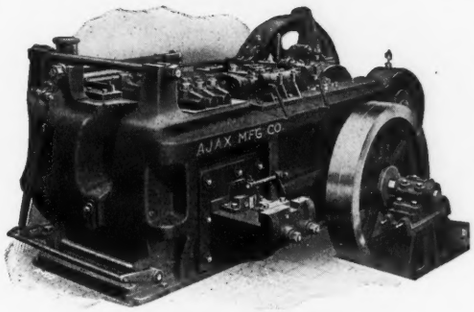

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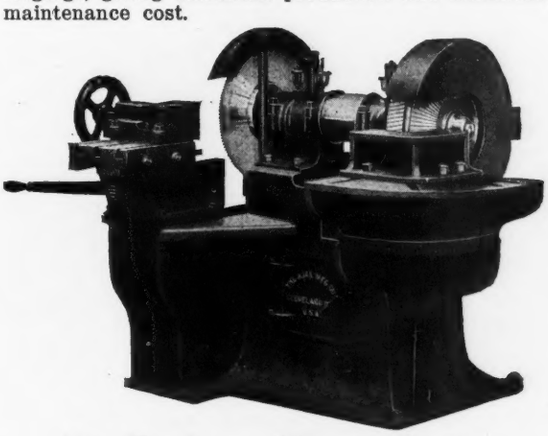

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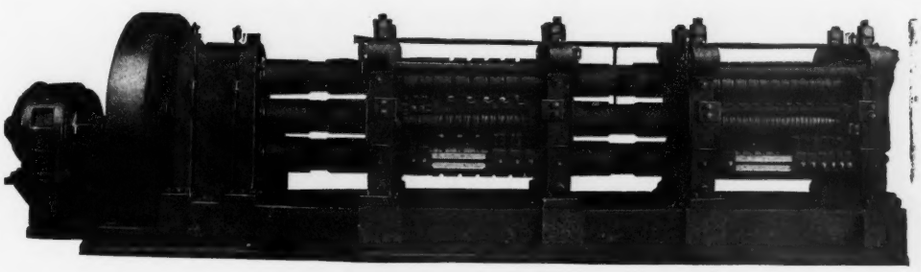

Reclaiming Rolls

By re-rolling scrap pieces of iron and steel bars to form good stock of smaller size, rolls of this type are saving railroad companies and large factories many thousand dollars yearly.

Makers of

Automatic Feed Rivet and Bolt Headers, Hand Feed Rivet and Bolt Headers, Continuous Motion Heading Machines, Bulldozers, (High Speed and Standard), Hot Sawing and Burring Machines, Axle Upsetting Machines, Reclaiming Rolls, Universal Forging Machines, Hot Pressed Nut Machines, Taper Forging Rolls.

more recently consulting engineer for L. V. Estes, Inc., Chicago, Ill., has become associated with the Business Service Corporation of America, Chicago, Ill., in the capacity of vice-president and chief engineer.

GEORGE R. WETTEN, who until recently was with the Cyclops Steel Co., of Titusville, Pa., has taken a position with the Hess Steel Corporation, Baltimore, Md. While with the Cyclops Steel Co., Mr. Wetten designed a new 12-inch mill for rolling carbon and high-speed tool steels, and he will do similar work for the Hess Steel Corporation.

D. B. CLARK is now in charge of the Cleveland Milling Machine Co.'s Indianapolis district and will handle it through the Chicago office. The Indianapolis office has been discontinued, owing to the death of W. P. Sparks, the former representative.

OSCAR WODACK, for several years Chicago representative for the James Clark Jr., Electric Co., Inc., Louisville, Ky., has resigned his position and organized the Wodack Electric Tool Corporation, 23-27 S. Jefferson St., Chicago, Ill. This concern will manufacture portable electrically driven drills and grinders.

ARVID E. NISSEN is now assistant superintendent of the melting shop at the plant of the Hess Steel Corporation, Baltimore, Md. Mr. Nissen was formerly with the Taylor-Wharton Iron & Steel Co., Highbridge, N. J., as assistant metallurgist and prior to that was in the open-hearth department of the Illinois Steel Co., Gary, Ind.

PAUL M. LINCOLN, for many years commercial engineer of the Westinghouse Co., has resigned from that organization to enter the consulting engineering field, and in that capacity will have active charge of motor application engineering for the Lincoln Electric Co. The work which Mr. Lincoln will take up with the Lincoln Electric Co. involves the entire problem of motor drives for machinery and more especially the determination of the proper type, characteristics, and size of motors best adapted for direct connection to various sizes and types of machinery.

RUSSELL W. STOVEL, who recently returned from France as Lieutenant-Colonel of Engineers, having served there as Chief of the Terminal Facilities Division of the Army Transport Service, has been appointed a consulting engineer of Westinghouse, Church, Kerr & Co., Inc., and will devote his entire time to the company's electrical and mechanical work. Mr. Stovel has had an unusually comprehensive experience in the electrical and mechanical problems connected with central power station and steam railroad electrification work—from the fundamental economics involved, to design, construction, equipment and operation—together with a valuable experience in mechanical handling at docks and terminals. Mr. Stovel received high commendation from the military authorities for his "splendid administrative abilities, to which are due the excellent results obtained by the Terminal Facilities Division of the Army Transport Service."

COMING EVENTS

January 6-8—Annual meeting of the Society of Automotive Engineers, Inc., in New York City, at the Engineering Societies Building, 29 W. 39th St.

January 8-15—First aeronautical exposition in the Coliseum in Chicago, Ill., given by the Manufacturers' Aircraft Association, Inc., 501 Fifth Ave., New York City.

February 2-6—First annual mechanical inspection equipment exposition and convention of the American Society of Mechanical Inspectors at the Hotel Astor, New York City. Secretary, Henry F. Winter, 35 W. 39th St., New York City.

May 15-20—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

NEW CATALOGUES AND CIRCULARS

Lakeside Forge Co., Erie, Pa. Catalogue P, listing the complete line of drop-forged wrenches, adjustable wrenches, and pliers made by this company.

Davis-Bournonville Co., Jersey City, N. J. Circular briefly reviewing autogenous welding, the opportunities for oxy-acetylene welders and cutters, and including the terms of instruction in the Davis-Bournonville Institute.

General Metals Co., 895 Greenwood Ave., Detroit, Mich. Booklet dealing with the construction and operation of the Trundle automatic multiple-spindle thread milling machine, which is a double-spindle machine designed for a high rate of production.

Edgemont Machine Co., Inc., Dayton, O. Catalogue G of friction clutches, extended sleeves, cut-off couplings, clutch pulleys, and countershafts. The standard dimensions of various clutches and couplings are given in tabular form.

Bausch & Lomb Optical Co., Rochester, N. Y. Illustrated 112-page catalogue of microscopes in which several new models and features are presented. In addition to the common types there are binocular, metallurgical, chemical, and other special types.

Independent Pneumatic Tool Co., Chicago, Ill. Illustrated circular describing a line of "Thor" portable electric drills ranging from the No. 000 size which has a 1/4-inch drilling capacity, to the No. 1 size which has a 9/16-inch drilling capacity.

Barrett-Cravens Co., 171 N. Ann St., Chicago, Ill. Circular descriptive of the Barrett lift-trucks equipped as trailers. The lift-truck is especially designed for use as a trailer behind a power unit, but it can also be employed as an ordinary lift-truck, operated manually whenever required.

Bearings Co. of America, Lancaster, Pa. Revised edition of the load and data sheets issued by this company, in which several additions have been incorporated. Copies will be sent to all interested, either from the main office at Lancaster or from the Detroit sales office at 1012 Ford Bldg.

Medart Patent Pulley Co., Inc., St. Louis, Mo. A sixteen-page booklet entitled, "The Clutch that Clutches." Various types of friction clutches and cutting-off couplings made by this company are illustrated and described. The advantages of the Medart V-groove friction clutch are especially emphasized.

Universal Machine & Tool Co., 601 Mahoning Road, N. E., Canton, Ohio. Leaflet descriptive of a special vise designed for use on planing, milling, shaping, drilling, and slotting machines in place of ordinary vises. The vise jaws are mounted upon angular ways to give an inward and downward clamping action.

Landau Machine & Drill Press Co., Inc., 19-25 W. 44th St., New York City. Circular on the Landau combination drill chuck and tapping machine consisting of a combination head, housing four independent spindles which can be quickly used for either drilling, tapping, reaming, or countersinking operations.

Garrison Machine Works, Dayton, Ohio. Catalogue of Johnson gear chucks of the pitch-line control type for chucking gears true with the pitch diameter. These chucks include designs for spur, helical, internal and bevel gears and sprockets. Illustrations are used to show the various applications of these chucks.

P. W. V. Automatic Machine Corporation, Fitchburg, Mass. Booklet entitled "The Index to Radical Construction," which precedes a new catalogue and which shows by an interesting series of photographs, the successive stages in the construction of the Radical automatic screw machine, the object being to show by this series of views the simplicity of construction.

Taft-Peirce Mfg. Co., Woonsocket, R. I. Bulletin devoted to various forms of production and inspection tools such as are used in connection with precision work. These tools include taper test-gages, sine bars, V-blocks, parallels, straightedges, angle-irons, bench plates, indicators, precision squares, and boring equipment for milling machines.

Lima Drill Press Co., Lima, Ohio. Booklet descriptive of the main features and advantages of the new multiple-spindle magazine drill press which has sixteen spindles, each of which can be quickly brought into the working position by turning the magazine, thus making it possible to perform sixteen different operations by equipping the spindles with the proper sizes of drills, reamers, countersinks, etc.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Pamphlet emphasizing the numerous applications of electrical heat by means of flat standardized C-H space heaters which are 2 feet long, 3/16 inch thick and 1½ inches wide. Typical applications are in crane and hoist cabs, meter houses, valve houses, and low-temperature ovens. Another booklet is entitled, "Electrical Operation of Gate Valves" and contains a reprint of an address by Peter Payne Dean given before the Metropolitan Section of the American Society of Mechanical Engineers.

Ingersoll-Rand Co., 11 Broadway, New York City. Booklet 8707 superseding 8606 and featuring "Little David" pneumatic drills, grinders and saws; booklet 5106 superseding 5006 on Type 47 "Radialaxe" coal cutter; leaflet 954 descriptive of the air lift method of pumping; booklet 963 explaining the various uses and advantages of compressed air in saw mills; leaflet 965 entitled "'Tis a Good Investment," illustrating ER and FR compressors in small machine shops, power houses, garages, etc.; booklet 9029, a pictorial products catalogue illustrating and describing practically the entire line of products manufactured by this company.

TRADE NOTES

Superior Machine Tool Co., Kokomo, Ind., manufacturer of upright drilling machines, has erected a new office building adjoining the factory.

Gairing Tool Co., Inc., Detroit, Mich., is the new name of the firm previously known as the Gairing Needham Tool Co., Mr. Needham having severed his connection.

Business Service Corporation of America, engineers and accountants, have opened an office at 29 S. LaSalle St., Chicago, Ill. Charles F. Scribner is vice-president.

Richardson-Phenix Co., Milwaukee, Wis., lubrication engineers and manufacturers, have again opened a Philadelphia office which is located in the Bailey Building and is in charge of George F. Fenno.

American Forge & Machine Co., Canton, Ohio, has recently added another steam hydraulic forging press to its forge shop. This enables the company to take care of a wide range of forging work, with facilities for rough-machining and heat-treating.

Rivett Lathe & Grinder Co., Brighton District, Boston, Mass., has let a contract for the construction of a three-story building, 200 by 60 feet. The building, which is to be of reinforced concrete, will be used for manufacturing, and will cost approximately $100,000.

Torrington Mfg. Co., Torrington, Conn., has let a contract for the design and construction of a new manufacturing building to the Aberthaw Construction Co. of Boston, Mass., at a cost of approximately $100,000. The new building will be 60 by 180 feet, two stories high, of reinforced concrete, and is expected to be ready for occupancy about the middle of February.

Wodack Electric Tool Corporation, 23-27 S. Jefferson St., Chicago, Ill., has been organized by Oscar Wodack, formerly Chicago representative for the James Clark Jr. Electric Co., Inc., Louisville, Ky., for the manufacture of electric drills, hammers, and grinders. Oscar P. Wodack is president and treasurer; A. K. Wodack, vice-president; and Albert T. Lochner, secretary and superintendent. They expect to have tools ready for the market about January 1, 1920.

Urban Machine & Tool Co., Inc., has been formed to take over the business of the Ohio Tool & Machine Co., at 2424 St. Clair Ave., Cleveland, Ohio. The product of the company is machine tools, and for the present it will specialize on an improved type of bench lathe. The company is incorporated for $100,000 and the officers are F. Urban, president; C. S. Sprigade, vice-president; K. L. Hayes, treasurer, and W. E. Keough, secretary.

Hammond Steel Co., Inc., Syracuse, N. Y., is completing extensive additions to its mills at Solvay, N. Y. The extensions include 16- and 10-inch rolling mills, straightening machinery, turning equipment, new electric furnaces, and annealing plants. The erection of a plant for cold-drawing will follow the completion of this work. The company will devote its efforts to the production of high-grade hammered and rolled tool and alloy steels, die-blocks, and special forgings.

National Automatic Tool Co., Richmond, Ind., manufacturer of multi-drillers, has placed a contract for a new addition to the plant which will be of steel and brick construction and will be equipped with modern machinery. It has been only three years since the plant capacity was doubled, but the increased demand for multi-drillers, both domestic and foreign, necessitates this additional building, which will enable the company to again double its capacity.

Swan & Finch Co., 165 Broadway, New York City, announces the purchase of the **Cataract Refining & Mfg. Co.** of Buffalo. The latter concern operates large lubricant plants at Buffalo and Chicago and has given particular attention to the development of specialties in grease lubricants, such as cutting compounds, drawing compounds, and practically every form of lubricating grease. The Swan & Finch Co. has been one of the leading oil and grease producers, so that this new acquisition will result in large and diversified production. Henry Fletcher, former president of the Swan & Finch Co., is chairman of the board of directors, and W. G. Moncrief, former president of the Cataract Refining & Mfg. Co., is president of the Swan & Finch Co.

General Motors Corporation is to build what is virtually a new plant at Meriden, Conn., for one of the subsidiaries, the New Departure Mfg. Co. The work includes the erection of four new buildings at Meriden and the remodeling of an old building, together with the construction of one new building at the West Hartford plant. Reinforced concrete will be used throughout. The Meriden plant will cover a total floor area of 340,000 square feet and consists of two new three-story and basement buildings, 302 by 82 feet, and two one-story and basement buildings, 67 by 302 feet. The old building, which is to be remodeled, is a three-story structure, 305 by 58 feet. At West Hartford, the work consists of one two-story building, with basement and sub-basement.

Syracuse Alloy Steel Co., Inc., Syracuse, N. Y., has reincorporated, the new company assuming the name of the old one. Property has been purchased in the eastern part of Syracuse and a plant is now being erected. This plant will be equipped with additional hammers and rolls sufficient to care for the rapidly growing business. The company, in addition to making high-speed steel in the standard forms of annealed bars, hardened tool bits, etc., is also manufacturing forged milling cutter blanks of standard types such as blanks for side milling cutters, end-mill cutters, etc., and is also manufacturing forged cutter blanks for special shapes of cutters as required by individual customers. It is anticipated that the new plant will be in operation early in 1920.